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THE FORBIN.

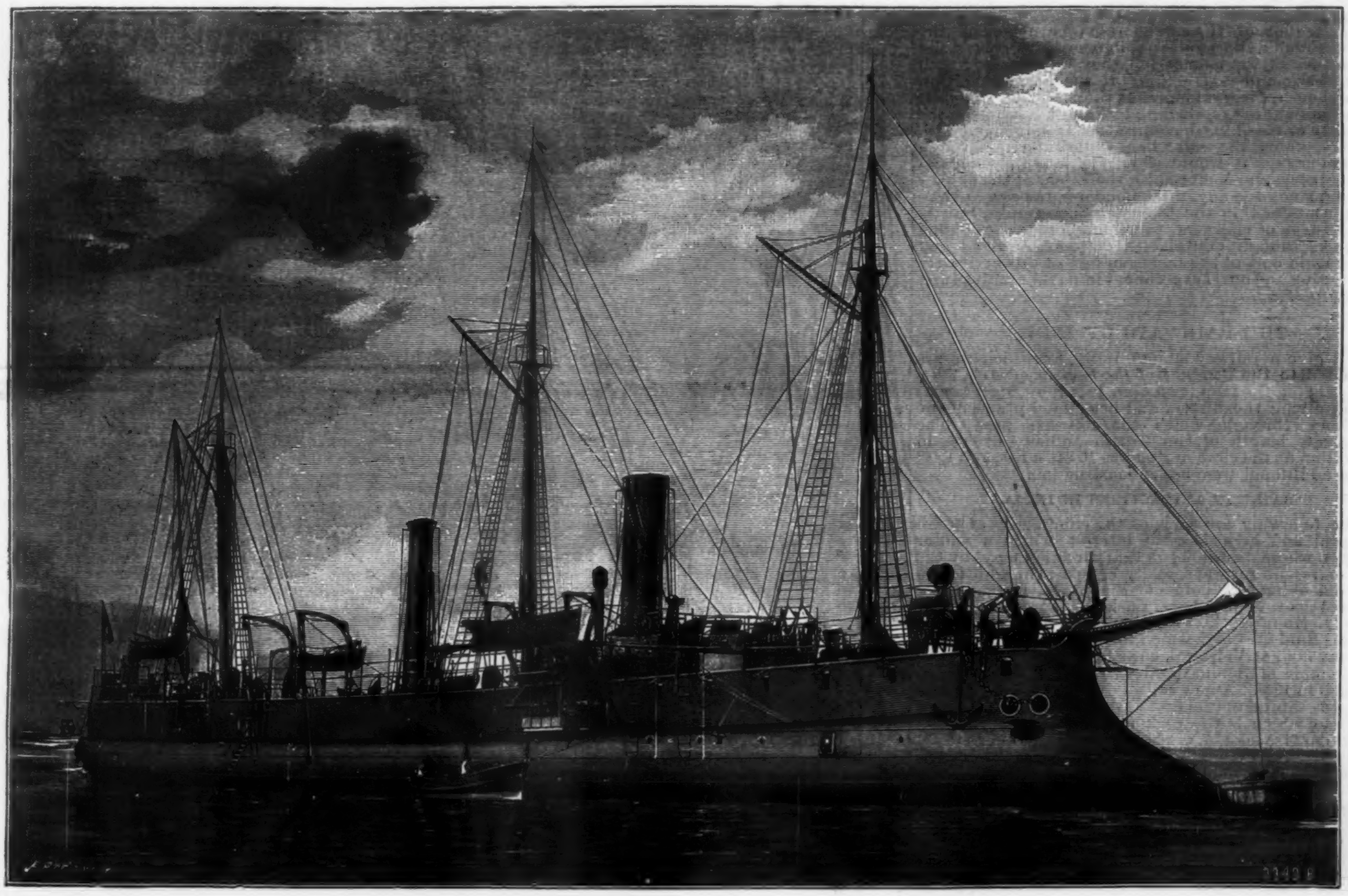
THE Forbin, of which we publish an illustration, is one of the most recent developments of the French navy; she belongs to the unarmored type of third class barbette cruisers, and is one of sixteen coming under the same category, though differing very widely in size, form, and efficiency, as will be seen from the table on the next page, taken from the *Aide-Mémoire de l'Officier de Marine*.

As will be seen from the table, this section of the French fleet consists rather of six than of sixteen vessels, the remaining ten having been built between 1867 and 1872; these smaller ships are all of wood, and, having only small engine power and single screws, have low speeds. They are, moreover, entirely without protection, and although they carry almost similar armaments to the new type, less the torpedo tubes, they cannot be considered as formidable ships in any sense of the word. The Coetlogon, Cosmao, Forbin, Lalande, Surcouf, and Tronde belong, however, to a very different category, and may be regarded as containing the elements of the most successful cruisers that will be added to the French navy in the early future. With a small displacement (under 2,000 tons) they possess relatively very great engine power and high speed; the coal storage is low, only 200 tons, but on the other hand they have a large sail area. They are not burdened with armor protection, except for the 1·5 in. steel deck, but they are belted with a caisson of cellulose, which it is considered will be of great utility without adding much to the weight. The armament is only moderate, but very efficient, consisting of 5·51 in. guns, machine and quick firing guns. With the rapid progress now being made in the size and construction of the last named class of weapon, it is probable that the number of these guns will be increased, and heavier calibers introduced, so that it is likely the main armament will consist of 15 centimeter quick firing guns. It is evident that the Forbin and her sister ship are highly successful experiments which will be repeated with considerable modification at an early date.

It should be mentioned that the Lalande and the Tronde, while having the same leading dimensions, are not built on quite the same lines as the Forbin, nor are the internal arrangements the same.

A writer in *La Marine Française* has recently published what appears to be a somewhat severe criticism on the Forbin; we cannot do better than summarize what he says on the subject to convey an idea of the appreciation of French critics upon this particular example of modern third class cruisers. The Forbin having given a speed of 21 knots during a two hours' trial and having proved that she could sustain this speed for a much longer period, or at all events that she can be safely classed as a 19 knot ship for fine weather, she is entitled to be reckoned as the fastest ship in the French navy. She is propelled by two horizontal compound engines supplied with steam from six boilers, and develops a total force of 6,000 horse power, which is used to drive two screws at a maximum speed of 140 revolutions per minute. Viewed from the shore, the Forbin has the appearance of a torpedo cruiser, but larger and much less sightly; her two funnels are of different sizes and are quite vertical. They offer a great contrast to the slight and badly arranged schooner rigging. While much longer than either the Condor or the Vautour (95 meters, as against 68 meters), the Forbin has almost the same height above water, so that she naturally appears lower sided than the shorter vessels. There is nothing in the form of the ship that suggests that it possesses so high a speed; the lines are generally unattractive as seen from the water, and she is evidently not adapted for bad weather. If, however, the Forbin is examined in a dry dock, the impressions it conveys are considerably modified, and its lines suggest much originality and boldness of ideas which have been justified by the high speed it has attained. Extremely fine forward, the form of the vessel suggests that it is better adapted for speed than for maneuvering; the distribution of weights is such as to give the ship a tendency to pitch heavily, and this tendency is increased by the very large diameter of the two screws—a diameter adopted to compensate for the comparatively slow speed at which they are driven—which also helps to keep the ship down by the stern. This low engine velocity is one of the weak points of the ship, which would certainly be better adapted for heavy seas if the screws could be driven at 200 revolutions instead of 140. That this would be possible is proved by the Piemonte, which, with 2,500 tons displacement and 12,900 horse power, has a velocity for her screws of 185 revolutions, or 45 more than that of the Forbin.

On board this cruiser the visitor finds a very restricted upper deck, interrupted aft by the officers' quarters, amidships by the cooks' galleys and by two 14 centimeter guns, and forward by a deck house forming the crew's quarters; the machine guns are distributed forward and aft. No special shelter has been provided for the captain from which he can fight the ship; it is true that vessels of this class are never supposed to allow themselves to be engaged except by an enemy much inferior in strength, but the absence of such a provision suggests remarkable negligence on the part of the designer, since an engagement may at any time be forced, and the ship find herself in action despite all the efforts of the commander. Descending from the upper to the main or armored deck, the arrangements, commencing with the bow and going aft, are as follows: A strongly framed water tight compartment adjoining the spur, which is useless and always kept empty; two torpedo tubes, one on each side of the ship; a central hatchway communicating with the upper deck, and from the armored deck to the chain shafts, the water and wine stores, and the forward powder and projectile magazines; the hospital, pharmacy, steward's room, and stores, and the hatchway for the forward stokehold. This group of installations occupies nearly the whole width of the ship, leaving a narrow passage on one side, and the ventilating trunk for the forward stokehold; vertical coal stores extending from the armored to the upper deck, with a passage on each side and a space in the center which serves as a sheltered position for a steam capstan, the chimney for the four boilers in the forward and midship stokeholds, and also two fans for exhausting the hot air, one for each stokehold; more coal bunkers, which protect the entrance to the midship stokehold as well as to the after one, and air trunks connected with the fans; the chimney for the two after boilers, two air trunks, one for the aft stokehold, the other for the forward engine room; a double hatchway for gaining access to the engine rooms, and which extends as far as the upper deck; a hot air exhaust for the after engine room; a third torpedo tube for launching automatic torpedoes; a hatchway leading to the auxiliary engine room, and which also gives access to the powder and projectile magazines aft; a fourth torpedo launching tube; an air trunk leading from the auxiliary engine room, and additional quarters for the crew.* In addition to these complicated arrangements, the available space afforded by the vessel is further occupied by a caisson entirely surrounding it and filled with cellulose. In the words of the writer whose remarks we are summarizing, the whole interior of the ship is filled with a long series of cells more or less awkwardly arranged, a collection of badly localized small spaces, and a veritable maze of *culs-de-sacs* extending from one end of the vessel to the other. A



THE FRENCH UNARMORED CRUISER FORBIN.

* The writer in *La Marine Française* makes no mention of the fifth torpedo tube.

TABLE GIVING GENERAL PARTICULARS OF FRENCH THIRD-CLASS BARBETTE UNARMOURED CRUISERS.

Name of Ship.	Date of Launching.	Material Used in Construction.	Length.		Beam.		Draught of Water, Aft.		Displacement.	Power.	Speed.	Number of Screws.	Storage for Coal.	Thickness of Protected Deck.	Armament.				Number of Machine Guns.	Number of Crew.	Number of Torpedo Tubes.	—
															Number of Guns.		Weight of Guns.	Number of Quick-Firing Guns.				
			ft.	in.	ft.	in.	ft.	in.	tons	I.H.P.	knots.		tons	in.		in.	tons					
Beautemps-Beaupré	1872	Wood	206	8	32	10	16	5	1246	985	12.6	1	250	..	six	5.51	3	..	8	154	..	Similar ship to the Forbin.
Coëtlogon ..	1888	Steel	311	8	29	6	17	2	1848	6000	19.5	1	200	1.58	four	5.51	..	3	4	150	5	Ditto
Cosmao ..	1889	,,	311	8	29	6	17	2¼	1877	6000	19.5	2	200	1.58	,,	5.51	..	3	4	150	5	
D'Estrées ..	1867	Wood	203	8	32	10	16	2	1340	1008	12.3	1	250	..	six	5.51	..	..	4	154		
Duchaffault	1872	,,	206	8	32	10	15	10	1289	1214	12.7	1	250	..	,,	5.51	..	..	6	154		
Forbin ..	1888	Steel	311	8	29	6	17	2	1848	5700	20.6	2	200	1.58	four	3.94	..	3	4	150	5	
Hirondelle	1869	Wood	206	8	29	6	13	2	1200	1800	16.4	2	150	..	two	5.51	..	..	8	114		
Hugon ..	1872	,,	249	1	32	10	16	6	1246	915	11.7	1	250	..	six	5.51	..	..	5	154		
Kerguelen ..	1872	,,	206	8	32	10	16	3	1235	1200	12.7	1	230	..	,,	5.51	..	..	2	154		
Lalande ..	1889	Steel	311	8	29	6	16	11	1877	6000	19.5	2	200	1.58	four	5.51	..	3	4	150	5	Ditto.
Linois ..	1867	Wood	203	5	32	10	16	0	1210	729	10.4	1	200	..	five	5.51	..	..	4	105		
Segond ..	1869	,,	206	8	32	10	16	1	1204	894	11.4	1	250	..	six	5.51	..	..	4	100		
Surcouf ..	1889	Steel	311	8	29	6	17	2	1848	6000	19.5	2	200	1.58	four	5.51*	..	3	4	150	5	Ditto.
Talisman ..	1862	Wood	223	1	32	10	16	2	1333	920	11.3	1	300	..	,,	5.51	..	..	4	154		
Tronde ..	1888	Steel	311	8	29	6	16	11	1877	6000	19.5	2	200	1.58	,,	5.51	..	3	4	150	5	Similar ship to the Forbin.
Volta ..	1867	Wood	206	8	32	10	16	8	1300	1006	13.3	1	230	..	six	5.51	..	..	5	154		

* This boat has also two 3.91-in. guns.

melinite shell bursting at any point in this labyrinth would cause an indefinite amount of damage for a distance of 30 or 40 meters, as has been well proved by the experiments with the Belliqueuse; the men stationed at the forward torpedo tubes would certainly be killed by any melinite shell bursting near the midship hatchway. More than this, as the armor deck is cut up with more than fourteen unprotected openings, any small caliber melinite shell falling down one of them would inevitably do very considerable damage. If such a shell burst in the hatchway leading to the powder magazines, the ship would be blown up; if it fell down one of the chimneys, the boilers would be partly if not wholly destroyed; if either of the ventilating trunks of the engine room be attacked, the engines would be stopped; in short, wherever the projectiles of the enemy fell, they would carry with them death and destruction. If the cellulose caisson be broken up, it would permit the water to pass over the armored deck, spreading fore and aft, altering the stability of the ship, since this deck is only about 8 in. or 10 in. above the water line, while entering through the hatchways it would penetrate into the compartments below and compromise the safety of the ship.

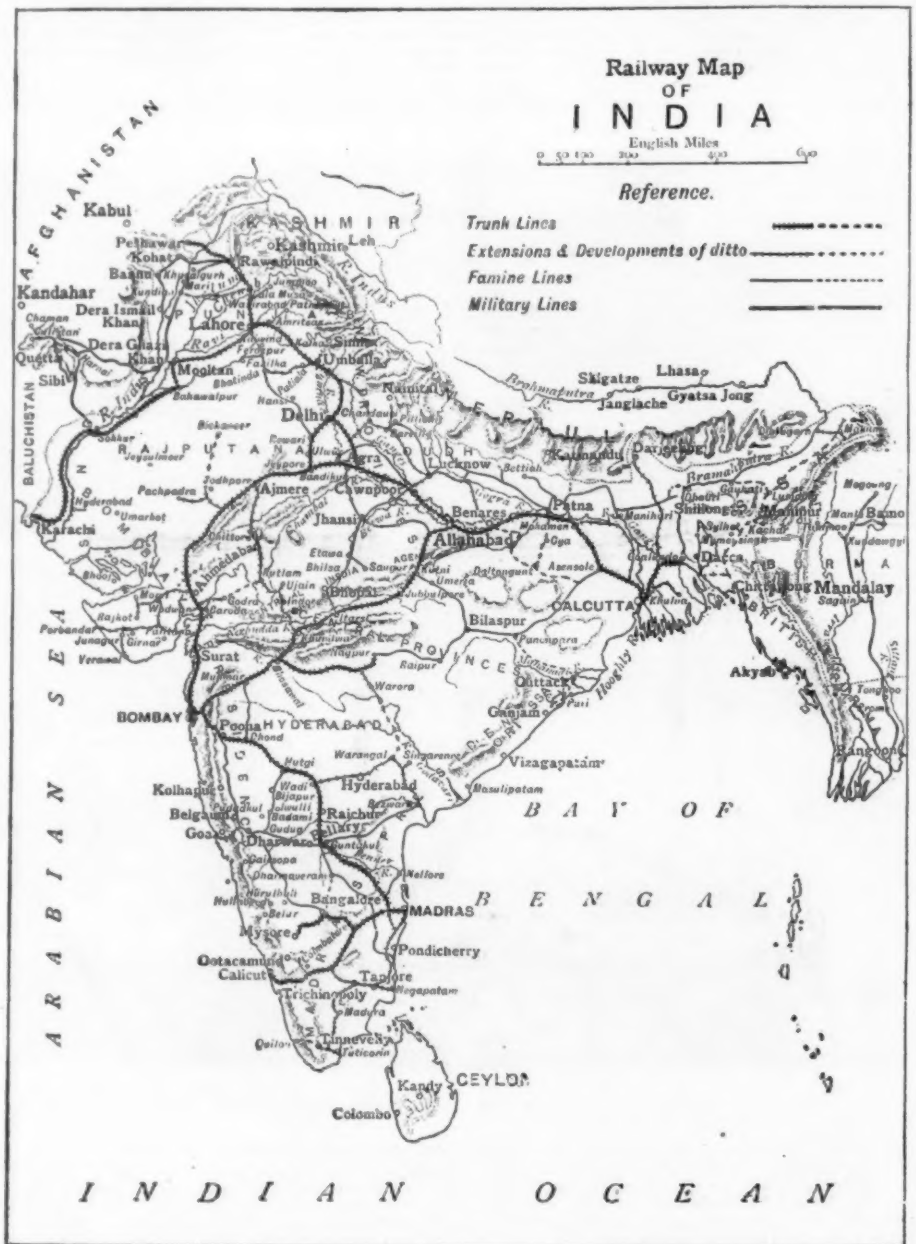
We do not by any means indorse the severe criticism contained in the foregoing paragraphs, but we think them of sufficient value to reproduce as giving an idea, though doubtless a very exaggerated and pessimistic one, of the shortcomings of this extremely interesting and novel experiment in naval architecture.—*Engineering.*

THE RAILWAYS OF INDIA.

WE give a railway map of India, for which we are indebted to the *Journal of the Society of Arts.* Accompanying the map is an able paper by Sir Thomas Hope, giving the history and brief descriptions of the territory through which the railways pass. The aggregate length of the British Indian railways in operation at the close of 1889 was 16,241 miles, and 1,442 miles additional were under construction.

RAILWAY ATTRACTIONS IN INDIA.

The following are some of the chief places of architectural and archæological interest which a winter tourist whose tastes lies in that direction may, by the aid of recent railways, easily compass, in addition to the old obligatory points of Elephanta, Karli, Ellora, Ahmedabad, Delhi, Agra, Lucknow, Tanjore, Trichinopoly, Madura, etc. Embarking at Bombay in one of the Sind steamers which touch at Kattiawar ports, he may land at Vairawal, close to the ruins of the famous temple of Somnath, destroyed by Mahmood of Ghazni in 1025. A new railway will take him to Junagur, the capital of the first native state in Kattiawar, close to which is the rock bearing the celebrated inscription of Asoka, B. C. 250, and two others of A. D. 151 and 457. A few miles beyond it, amid lovely scenery, stands the sacred mountain of the Jains, Girnar, 3,500 feet high, bearing a group of ancient and highly venerated temples. Continuing by the railway, the traveler will pass within a few miles of an equally sacred and more popular Jaina mountain, Palitana, whose summits are covered by many hundred temples, of every date from that of Westminster Abbey to the present generation, of every size and splendor, up to one which cost £170,000 some 50 years ago. Here, says Fergusson, the philosophical student of architectural art may see "the various processes by which cathedrals were produced in the Middle Ages, carried on on a larger scale than almost anywhere else, and in a more natural manner." On no account should a visit to Palitana be omitted. Continuing hence through Ahmedabad, which abounds in mosques, exquisitely decorated by Hindoo architects, of whose work two large perforated stone windows are a notable specimen, and touching, if time allow, at Sidhpur, to see the Rudra Mala temple (A. D. 943), the traveler reaches Abu Road. Hence he rides up to the lovely hill and lake of Abu, distinguished by a group of marble temples, comprising two of the most beautiful in India, which are covered with delicate and rich ornament of the best period of art (A. D. 1032–1247). The railway next takes him to Ajmere, where there is a mosque formed of pillars from Jaina temples destroyed by Mahometan conquerors, and from thence by a short excursion on another line to Chittore. This fortress, which fell to Alaudin in 1303, after a ten years' siege in the cause of one as fair as Helen, abounds in very ancient and beautiful buildings, of which I may name two towers. One of them is unquestionably the most beautiful tower in India, as that of the Kootub is the loftiest and finest. It belongs to the ninth century. Returning to Ajmere the railway proceeds to Jeypur, a splendid modern native capital, with its ancient stronghold, Amber, in the hills close by. Next comes Ulwur, where amid many beautiful buildings, proving that in Rajputana architecture is still a living art, stands the graceful cenotaph of Raja Bakhtawar, erected in the present century. Hence the traveler will no doubt visit Delhi, Muttra, Bindrabun, Agra, and perhaps other spots in Northern India. From Agra the Indian Midland Railway will take him to the



picturesque rock fortress of Gwalior, with its Jaina temple (A. D. 1093), and on to the railway station of Bhilsa, and a group of Buddhist Topes, of which that of Sanchi is the most famous. A cast of one of its gateways stands in the South Kensington Museum. Passing through Bhopal, and over the Great Indian Peninsula Railway, from which excursions are feasible to Ajunta and Ellora, the Southern Mahratta Railway, a railway of the present decade affording rare architectural facilities, begins at Hutgi. Thence we soon reach Bijapur, a vast city ruined by Aurungzebe in 1686, repiete with magnificent mosques, tombs, and palaces, among which stands pre-eminent the tomb of Mahmud, a dome structurally most interesting, which, in its internal diameter, rivals St. Peter's and the Pantheon at Rome, and surpasses St. Paul's by 27 feet. At Badami station a short time may be pleasantly devoted to the cave temples there, and to trips to Patadkal and Aiwalli, which possesses very numerous temples of the 6th, 7th, and 8th centuries. Those at the former are in the Dravidian style. Aiwalli possesses Jaina and Brahmanical caves, as also an ancient temple of Vishnu in the Chalukyan style, with apse, which is believed to be unique. The next point of interest is the extensive ruined city of Vijayanagar, also called Humpi, near Hospett station. The locality is highly picturesque, the temples numerous and extensive, in both the old and modern forms of the Dravidian style. Among the former the Temple of Vithoba (A. D. 1520) is conspicuous. Returning to the west and south by the same railway, a trip to Goa and back is replete with natural, historical, and architectural interest. Again, Guduck, Belgam, Hubli, Bunkapur, Kirwati, Lukmeshwar, Mungur, and other places on or near the line, possess interesting remains; and from Rani Bennur station the traveler who has friends in the locality may, with their aid, run down to the Falls of Gairsoppa, 890 feet high, with a fine volume of water. But the next really great place of interest, easily accessible from Banawara station, is the magnificent temple of Hullabeed (A. D. 1310), with Belloor and Huruihullee in its immediate vicinity, comprising the finest examples of the Chalukyan style. Replete with splendid temples as is Southern India, it would be beyond my text to wander there. By one route or another the visitor of Southern India can eventually return to Guntakul junction of the Madras and Southern Mahratta Railways, and may proceed thence by a picturesque descent of what may be termed the Eastern Ghats, to Bezwara on the sacred Krishna. Within a short distance are the remains of Amravati, which, with Bhilsa, already noticed, and Manikyala in the Punjab, constituted the great triad of Buddhist topes in India. Unfortunately, far more may be seen and understood about it in the South Kensington Museum, and the pages of Fergusson's "Tree and Serpent Worship," than on the spot. The locality has, however, various forms of interest, and the Nizam's new railway offers a pleasant return by his capital, with Jaina buildings at Warangal on the way.

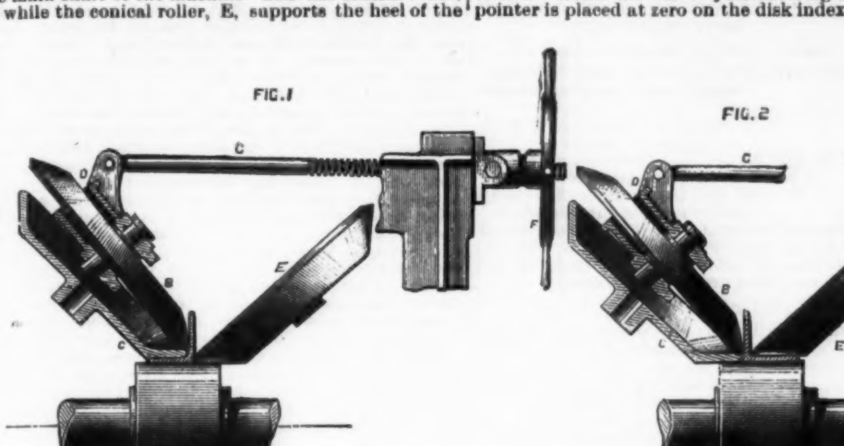
SIR THEODORE HOPE.

ANGLE IRON BEVELING MACHINE.

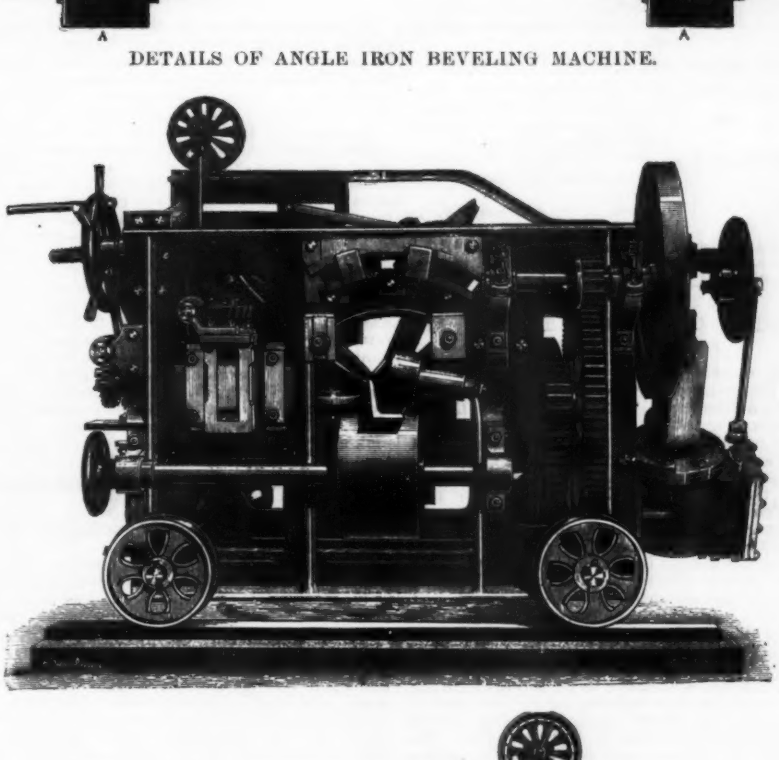
IT is about six years since Messrs. Davis & Primrose, of Leith, introduced to the shipbuilding trade a machine for beveling the angle bars used in the construction of the frames and stringers of iron ships. Since then they have purchased the patent rights of that machine and taken out two patents of their own for beveling machines, in which valuable improvements are embodied. Machines of their manufacture are now to be found in most of the large shipbuilding yards in this country and the Continent, also in the dockyards of our own and several foreign governments.

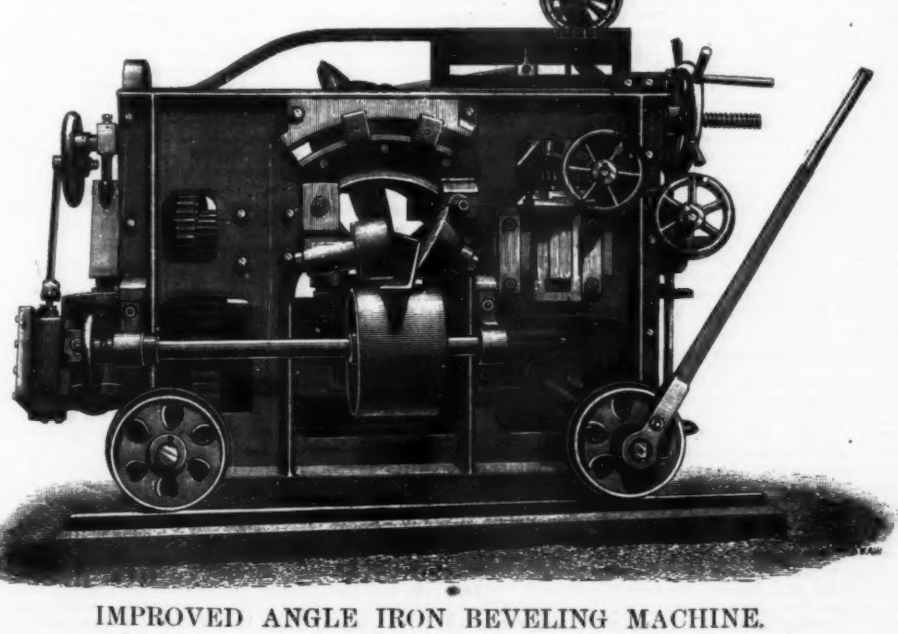
The illustrations show side views of a beveling machine, according to the latest arrangement of the patentees. To make the action of the machine more easily understood, we also give herewith two diagrams of the principal rollers. From Fig. 1 it will be seen that when it is required to open out the angle of the bar, or make obtuse angles, one web of the bar is held between the drum, A—which is mounted on the main shaft of the machine—and the conical roller, C, while the conical roller, E, supports the heel of the bar and prevents it sliding along the drum, A, when the beveling roller, B, is brought into action to press over the standing web. The roller, B, is carried in a frame, D, guided in quadrants, and to this frame is coupled the connecting screw, G, which passes through a nut in the eye of the hand wheel, F. By turning this hand wheel the roller, B, is brought over to any desired angle, and the exact angle to which it is pressing over the standing web of the bar is indicated on the angle index, the pointer of which is connected by a light rod with the frame, D, as is seen on the side view of the machine. The portion of the bar, as regards length, that is being beveled at any moment, is indicated on the disk or travel index, seen standing above the angle index. The pointer of this index is loose on its spindle, but can be fixed to revolve with it by means of a thumb-screw. The revolving motion is effected by means of a worm keyed on the main shaft, and a train of gearing. Each division on this index represents the passage of 4 ft. of the bar through the rollers. When the bar is just entering the rollers the pointer is placed at zero on the disk index and fixed by the thumb-screw, then when 4 ft. of the bar has passed the rollers the pointer will have moved to 1 on the index, and when 8 ft. of the bar has passed the pointer will be at 2, and so on.

Fig. 2 shows the rollers as adjusted for making bars with acute angles or doing what is termed shut beveling. In shipbuilding the section of bar most generally used is L, but the machine operates equally well on other sections that are occasionally employed, such as ⌐ and ⊥. The whole of the beveling being done on the bar as it is pulled out of the furnace at a speed of about 40 ft. per minute, the bar is hot enough when delivered on the beveling blocks to be turned round to the shape of the mould without reheating.



DETAILS OF ANGLE IRON BEVELING MACHINE.





IMPROVED ANGLE IRON BEVELING MACHINE.

The work being done by rollers, the bar has its webs rolled quite flat, free from hollows and without hammer marks; the rough edges of the rivet holes are flattened down, and the bar finished in a style quite unattainable by hand labor. The machine is mounted on rails placed in front of the furnace, that is, between the furnace mouth and the leveling blocks, and is moved along the rails when necessary by means of the ratchet lever shown as shipped on the right hand axle.—*The Engineer.*

TO ADJUST AND READJUST COMPASSES AT SEA.

IN an iron ship or steamer the combined effect of the sub-permanent magnetism of the *hard* iron and the transient induced magnetism of the *soft* iron produces a deviation of the compass on the different points as the ship is turned in azimuth.

Briefly stated, the disturbing forces acting on the compass, resulting from the proximity of iron partly hard, partly soft, and partly in an intermediate condition, are of the following character:

1. The sub-permanent magnetism of the hard iron causes a semicircular deviation inversely proportional to the horizontal force of the earth.

2. The transient magnetism induced in the soft iron by the vertical force of the earth causes a semicircular deviation proportional to the tangent of the dip.

3. The transient magnetism induced in the soft iron by the horizontal force of the earth causes a constant deviation, and also a quadrantal deviation, both independent of the latitude.

The forces here indicated are such as admit of a mechanical correction or compensation by means of magnet bars, and soft iron either in the form of balls or chain; for, since this iron retains the same place relatively to the compass and to the ship, the data for the correction are, not the shape and position of the iron, but its effect on the needle in a certain number of positions of the ship as shown by the disturbed compass.

Instruments required.—The amount and character of the necessary mechanical correction, and the disposition of the various correctors, may be determined by calculation. In the present instance the method is by the *tentative* process, viz., by means of the dumb card or by the compass itself, and using a distant object, the magnetic bearing of which is known; or otherwise, time azimuths of the sun converted into correct magnetic bearings. If the ship be brought up to a buoy, the distant object is the readiest; for a ship in the open the sun's bearings are indispensable; and thus the compass, by the proper appliances, can be adjusted to indicate magnetic courses and bearings.

The magnets, of various lengths if they are to lie on the deck, or all of the same length if to be inserted within the binnacle, should have the N.-seeking end distinctly marked and the middle of each magnet indicated.

Of the soft iron, there should be chain enough to fill the boxes; but if balls be used, their power on the needles should be tested before taking on board.

As a preparation, if you choose, or if you deem it necessary, you can draw two chalk lines, one fore and aft, and the other athwartship, crossing exactly below the center of compass; the middle of the correcting magnets should lie on these lines.

The mechanical correction of the compass, on the basis of the character of the forces producing the deviation, is divided into three parts, each of which must be separately considered, and in the natural order:

(1) The correction of the semicircular deviation; (2) the correction of the quadrantal deviation; and (3) the correction of the heeling deviation.

The effect of the hard iron on the compass gives rise to a single disturbing force, which might be approximately corrected by a single magnet, if properly placed; but it is usual, on Sir G. B. Airy's principle, to consider it as two disturbing forces—one acting *fore and aft*, and the other acting *athwartship*.

The order in which you must make the corrections of the deviation is as follows:

First take two *adjacent* cardinal points; thus, if you begin at N., you must next take E. or W.; similarly, if you begin at S., you must take E. or W. If you begin at E. (or W.), you must then take N. (or S.) Two adjacent points are imperative. Then one or other of the intermediate points, N.E., S.E., S.W., or N.W., as convenient.

The order and method of proceeding are more fully explained as follows:

1. Bring the ship's head to one of the cardinal points *correct magnetic*, say W. or E.; then, if the compass show an error, place the compensating magnet fore and aft on port or starboard side, its middle on the thwartship line with the center of the compass, N. end aft if compass N. is drawn aft, but N. end forward if compass N. is drawn forward; approach the magnet toward the compass until it points correct magnetic as required.

2. Next bring ship's head N. or S. *correct magnetic.* If the compass indicates an error, lay the compensating magnet athwartship, its middle on the fore and aft line with the center of the compass, N. end toward the side (port or starboard) to which compass N. is drawn; approach the magnet toward the compass until it points correct magnetic as required.

NOTE.—*It is advisable to leave about 1½° of the semicircular deviation uncorrected at the N. and S. points, and about ½° at the E. and W. points, the deviation so left to be westerly if the ship has been swung from left to right, easterly if from right to left.*

3. Now bring ship's head on one of the quadrantal points, N.E., S.W., S.E., or N.W., *correct magnetic;* if N.E. or S.W. by ship's compass have easterly deviation, or if S.E. or N.W. have westerly deviation, put soft iron (chain or correctors) on the starboard and port sides of compass; if the reverse, on the fore and aft ends of compass.

NOTE.—*It matters not on which cardinal point you commence; if at N. or S. correct magnetic, you must*

next go to E. or W., then to a quadrantal point. The magnets compensate the sub-permanent magnetism, and the soft iron correctors compensate the induced magnetism of the ship.

4. For the *heeling error;* if on heeling ship, head being N., the N. end of the needle is drawn to the high side, place a small magnet *vertically*, N. end uppermost, below the center of the compass, and in such position that the error disappears. If the attraction is to the low side, the vertical magnet must be placed S. end uppermost.

NOTE.—*The* HEELING *deviation is best corrected through the agency of a dipping needle.*

All that has been here indicated must be determined and rectified through the agency of a *dumb card*, or the *ship's compass with sight vanes.*

By the *use of the dumb card* the determination of the deviation, as the ship is swung round, is a simple operation. Clamp the respective bearings of the distant object (or the sun) from time to time; turn the sight vanes on the object, and the lubber's line will indicate on the dumb card the magnetic direction of the ship's head: with this indication the compasses can be compared, and the necessary corrections made.

If you use the ship's compass, with sight vanes, but no movable azimuth circle as a dumb card, then carefully proceed as follows:

Let us suppose that you are to be off the entrance to the Tyne in lat. 55° N. on October 25, with the sun's declination 12° S., you must previously prepare, from Burdwood's azimuth tables, a tabular form as follows, allowing about 20° of W. variation for the conversion of true bearings into magnetic:

App. Time A. M. H. M.	True bearings.	Mag. bearings.
9 40	N. 144° E.	S. 16° E.
9 48	146	14
9 56	148	12
10 04	150	10
10 12	152	8
10 20	154	6
10 28	156	4
10 36	158	S. 2° E.
10 44	160	South.

We propose to correct the *E. point first.* Bring ship's head by compass, say S. 56° E., and test the deviation. At 9h. 40m. the sun bears by compass S. 12° W.; the magnetic bearing by table being S. 16° E., the deviation is consequently 28° W., making the magnetic direction of the ship's head S. 84° E. Place a magnet fore and aft of the starboard or port side of the binnacle—the N. marked end aft—and such that it shall make the compass read S. 84° E.

Test by sun's bearing again; suppose at 9h. 48m. the sun's bearing by compass is S. 11° E., the magnetic bearing being S. 13° E.; the deviation is now 3° W. on S. 84° E., making ship's head magnetic S. 87° E.; finally move magnet toward the compass to correct 3° of deviation, and the E. point is adjusted, since at 9h. 52m. sun's bearing by compass and magnetic bearing are alike S. 13° E.

Similarly correct the N. point. Bring ship's head N. by compass: at 10h. 4m. compass bearing of sun is S. 18° E., and magnetic bearing by table S. 10° E., giving deviation 8° E. on compass north. Place a magnet athwartship, before or abaft the compass, N. marked end to starboard, to correct 7° or 8°. Test by sun's bearing again: at 10h. 12m. sun bears by compass S. 8° E., which, by table, is also the magnetic bearing of the sun; hence the N. point of the compass is correct magnetic.

Lastly, bring ship's head N. 40° E.; at 10h. 20m. table gives sun's magnetic bearing S. 6° E., compass gives S. 12° E., or 6° E. deviation; place soft iron correctors on starboard and port sides of binnacle to correct 5° or 6°, possibly making the compass magnetic at N.E.; but test it by bearings.

In placing the soft iron correctors, be careful that the compass card moves in the plane of the central line of each corrector.

Having read this part carefully, you will now see how to make any other necessary corrections; you must then swing ship round for any residual deviations in the other quadrants, and tabulate these for use, as required.

Thus far no reference has been made to the *Flinder's bar.* It has already been stated that the magnets are for the purpose of correcting *two* disturbing forces, but, as a fact, there are *three* disturbing forces; one acting *fore-and-aft*, one acting *athwartship*, and a third acting *vertically.* The *fore-and-aft* magnet will, for a given locality, correct the first and last; but on change of geographical position the vertical force alters, and therefore the E. and W. points may be over or under corrected. Hence the utility of the Flinder's bar. You may not make the correction exactly perfect on the first attempt, but it is always safe on finding a large E. deviation on the W. point of the compass, or a large W. deviation on the E. point, to place a vertical bar of soft iron in front of the compass, such that it shall correct from a third to half the deviation on the E. and W. points, and for the remainder of the deviation correct by the fore-and-aft magnet. After the ship has been to the equator, and especially if she has remained in a low latitude two or three months, the exact amount of Flinder's bar may be determined, and a better correction made.

Practical rules for the correction of the semicircular deviation at sea when the compass has been previously corrected by magnets.—If in the lapse of time, or through any considerable change of magnetic latitude, it is found that the deviation card no longer correctly indicates the deviation, you can correct the semicircular deviation by attending to the following rules: By *Time azimuths, or bearings of distant terrestrial objects* bring the ship's head to any of the cardinal points, *correct magnetic;* then you must move the magnets as required, and on the basis already indicated, for two *adjacent* cardinal points, and subsequently test the correction for the remaining two cardinal points; and then bring the ship round to the other points, for a deviation table.

I. For ship's head brought *correct magnetic* north or south, the correcting magnet lies athwartship, with its N.-marked (*red*) end to starboard or port, according to the original deviation. Then proceed to move the correcting magnet as follows:

(*a*) *Thwartship magnet with N.-marked end to starboard—*

Ship's head N., with E. dev. (*i. e.* compass N. to starboard) move magnet nearer.
" " " W. dev. (*i. e.* compass N. to port) move magnet further off.
Ship's head S., with E. dev. (*i. e.* compass S. to starboard) move magnet further off.
" " " W. dev. (*i. e.* compass S. to port) move magnet nearer.

(*b*) *Thwartship magnet with N.-marked end to port—*

Ship's head N., with E. dev. (*i. e.* compass N. to starboard) move magnet further off.
" " " W. dev. (*i. e.* compass N. to port) move magnet nearer.
Ship's head S., with E. dev. (*i. e.* compass S. to starboard) move magnet nearer.
" " " W. dev. (*i. e.* compass S. to port) move magnet further off.

II. For ship's head brought *correct magnetic* east or west, the correcting magnet lies fore-and-aft, with its N.-marked (*red*) end aft or forward, according to the original deviation. Then proceed as follows:

(*c*) *Fore-and-aft magnet with N.-marked end aft—*

Ship's head E., with E. dev. (*i. e.* compass E. to starboard) move magnet further off.
" " " W. dev. (*i. e.* compass E. to port) move magnet nearer.
Ship's head W., with E. dev. (*i. e.* compass W. to starboard) move magnet nearer.
" " " W. dev. (*i. e.* compass W. to port) move magnet further off.

(*d*) *Fore-and-aft magnet with N.-marked end forward—*

Ship's head E., with E. dev. (*i. e.* compass E. to starboard) move magnet nearer.
" " " W. dev. (*i. e.* compass E. to port) move magnet further off.
Ship's head W., with E. dev (*i. e.* compass W. to starboard) move magnet further off.
" " " W. dev. (*i. e.* compass W. to port) move magnet nearer.

It is to be hoped that I have made the subject of adjusting and readjusting compasses intelligible in this brief space.—*W. H. R., in Nautical Magazine.*

PICK'S SYSTEM OF MANUFACTURING SALT IN VACUO.

AT a recent meeting of the Society of Engineers, London, the following paper was read by Mr. Perry F. Nursey (past president), on "Pick's System of Manufacturing Salt in Vacuo:"

The subject of salt manufacture does not, perhaps, at first sight appear to be one which presents many points of interest to the engineer. That, however, is, if not the fault, at any rate the misfortune of that industry, which has been obliged, by force of circumstances, to drag on a tolerably monotonous and unchangeful existence for some centuries past. Not but what invention has always been more or less busy in this direction, as it has in others, but the practical results have been, so far as scientific progress is concerned, practically *nil.* Improvements have, of course, been proposed from time to time, but of these the bulk have shown themselves to be, on the face, utterly impracticeable. Others have been submitted to the test of practical application, and have been found wanting, while a few improvements relating to one or other of the details of the antiquated open brine pan system alone have survived the ordeal of working trial. The attempts which have been made to modify the ordinary pans and furnaces have at the best resulted in such a small increment of success as regards improved results of working, that it has long been evident that substantial improvement could only be the outcome of a radical and thorough change. This radical change has now been effected by Dr. Sigismund Pick, of Szczakowa, Austria, who has for many years past devoted his attention to the subject in connection with chemical manufactures, on which he is a high authority. This change having been made by means of special apparatus, the author conceives that the time has arrived when the manufacture of salt will be brought more absolutely and in a more pronounced manner within the domain of the engineer than it hitherto has been. Dr. Pick's system also marks a scientific advance, and therefore appeals to scientific men, several of whom of the highest reputations have inspected the working of the system, and have stamped it with their approval.

ORDINARY PROCESS OF SALT MANUFACTURE.

Before proceeding to describe Dr. Pick's system, the author will briefly indicate the ordinary method of salt manufacture. And here he would observe that it is a remarkable fact that, notwithstanding the splendid advances which science has enabled almost all our other industries to make, it has hitherto failed to influence or promote in any material degree the manufacture of salt. Neither chemistry nor mechanics, nor the two combined, have been able practically to raise that important and widespread industry above the level at which our remote ancestors found and left it. The air of sweet simplicity which antiquity impressed upon salt making appears to be still largely preserved to it, and the production of an important article of daily consumption by the whole human race is in the main left untrammeled and unfettered by any of the least of those scientific considerations which permeate all other industrial processes, including those of comparatively minor importance. Chloride of sodium, or common salt, occurs in nature chiefly in two forms, either as rock salt forming extensive deposits, or disseminated in minute quantities through the strata forming the earth's crust. Water penetrating the layers of rock salt and exerting there a solvent action, gives rise to brine springs. There are extensive rock salt mines, and salt is in some places produced by dissolving the rock salt and evaporating the brine thus made. But the chief supply of salt is obtained from brine springs, and the production of white salt from brine is a very simple process. Salt being soluble almost equally in hot and cold water, it is only necessary to keep the brine boiling and by this means to evaporate the water by which it is held in solution, the salt being precipitated in proportion as the water is driven off. The simplicity of the process is probably the reason why the improvements of modern engineering have not hitherto been brought seriously to bear upon it. Precisely the same method of manufacture is pursued all over the world. The brine is evaporated in open iron or steel pans of various shapes, usually rectangular, heated by open fires, and the precipitated salt is raked out, drained, and dried. As a sample, the author will take the ordinary wrought iron evaporating pans, which have an area of from 600 to 1,000 superficial feet. Their usual form is that of an oblong square, and their depth ranges from 12 to 16 inches. There are three or more fires under each pan, and there is usually a separate pan house to each pan—a salt works having any pretensions to a good output occupying considerable area of ground. At one end of the pan house is the coal store and the firing holes, while at the other is the chimney stack. Along each of the two sides is a walk, 5 or 6 feet wide, and between these walks and the walls of the pan house long benches, 4 or 5 feet wide, are fixed, on which the salt is placed in conical baskets to drain, after it has been taken out of the pan. In some pan houses there are no benches, the salt being deposited on drainers on the floor. The house is covered with a wooden or a slated roof, with openings for allowing the free exit of the steam. The fires under the pans are regulated according to the quality of the salt which is to be obtained. The finer the grain it is desired to give the salt, the more intense must be the heat applied.

DISADVANTAGES.

The disadvantages of the ordinary system of salt making are numerous as well as serious. In the first place, although the salt is raked out regularly, it is found impossible to keep the bottom plates of the pans quite free from it. This deposit, together with the salts of lime and magnesia present in the brine, however carefully the operations be conducted, forms a scale upon the plates which causes them to rapidly burn away and buckle or bend. Repairs are consequently constantly going on in salt works; and indeed this item of maintenance is one of the most serious in a salt manufactory. The finer the salt produced, the heavier are the repairs, and the more frequently the pans require cleaning, the scale having to be frequently chipped by chisels from the plates and damaged plates to be replaced by new ones. These pans cover a large area, and they can never be kept tight. The author has seen some of these broken-down salt pans under repair, and a more melancholy picture he has never beheld. He has seen rolling mills which have stood for a week or two after a breakdown, and they looked dismal enough. He has been on board a fine steamer, the Edith, after she had been some months submerged in Holyhead harbor, and had just been raised, and she looked hopelessly wretched, but for a real genuine picture of downright desolation, he gives the palm to a disabled brine pan. And it does not take long to disable them either, as may be imagined when it is stated that with the most careful working, and the best occasional patching, the life of a brine pan cannot be put at more than about three years.

Besides repairs to the pans, there is another heavy item of expense in the manufacture of salt which has to be considered, and that is the fuel bill. In order to maintain the brine at the boiling point, and to secure the proper rate of precipitation of the salt according to the quality required, a large consumption of fuel is necessary. There is yet another evil connected with the open pan system to which reference should be made, and that is the production of noxious gases, the effects of which are readily recognizable in the vicinity of salt works. As soon as scale begins to form in the pans the buckling action commences, the rivet seams open, and the brine leaks from the pans into the fire holes, producing gases which are alike deleterious to animal and vegetable life. To sum up, the ordinary process of salt making is slow and costly, and the output is comparatively small in proportion to the area occupied by the works and the quantity of fuel consumed. It is therefore not without satisfaction that the author is able to place before the society, and through it the salt industry, an invention by which the cost of production is greatly reduced, the output largely increased and, above all, the manufacture of salt successfully raised from a mere plodding process to a scientific system.

DR. PICK'S PROCESS.

As already stated, this important innovation is due to Dr. Pick, whose process is simple, automatic, and continuous, and while requiring only about two-fifths of the fuel at present necessary for the manufacture of salt, can be worked with a minimum of unskilled labor. Moreover, the apparatus being worked under vacuum and heated by steam instead of by fire, the wear and tear is practically *nil*, while the products are of the highest quality, and the output exceptionally rapid and large. The secret of success lies in being able to materially quicken the process of production without risk of damage to the products and without increasing the absolute heat, but rather by reducing it and at the same time reducing the expenses both of working and maintenance. The invention depends for its success upon two circumstances mainly. The first is that the boiling point of any liquid is lowered by reducing the pressure under which evaporation is carried on, and the second that the steam generated by the evaporation of any liquid contains a certain amount of latent heat which is sufficient to evaporate another quantity of liquid, provided the boiling point of the latter is below the temperature of the steam used. Dr. Pick, in fact, introduces into the salt industry principles similar to those upon which the Rillieux or triple effect system depends, which system is, as is well known, in use for the evaporation of liquids in certain other manufactures. Attempts have been made to apply the principle of multiple evaporation to the manufacture of salt, but the fact that none of these attempts has hitherto succeeded in practice proves that there was something wanting in the apparatus. The missing link has been supplied by Dr. Pick in the vacuum filter, which he has ingeniously engrafted upon the Rillieux apparatus.

THE APPARATUS.

As will be seen from the illustration, Dr. Pick's apparatus consists of three separate but duplicate sections, each section consisting of four main and closely connected parts. These are the boiling chamber, A (Fig. 1), the heating chamber, B, the collecting chamber, C, and the filtering chamber, D. The three sections are placed side by side a few feet apart, and they are connected together by pipes as shown. The heating chamber, B, of the first section is placed in communication with a steam boiler, or with the exhaust steam from an engine, by means of the pipe, E. The boiling chamber, A, of the first section is placed in communication with the heating chamber, B^1, of the second section by means of the pipe, F. the boiling chamber, A^1, communicating in its turn with the heating chamber, B^2, of the third section by the pipe, F^1. This latter section has its boiling chamber placed in communication with a jet condenser and air pump as shown. G is the brine inlet pipe to the various sections which is in communication with the brine tank, the brine being raised by vacuum and supplied automatically to the several sections. H is a pipe for automatically conducting the brine from the filtering chambers, D, D^1, and D^2, to the boiling chamber of each section, under the special conditions which will be explained when the author describes the modus operandi of Dr. Pick's system. J is a small pipe which connects the boiling chamber of the first and second sections with the condenser, and is used for assisting in maintaining a vacuum in each of those chambers. In like manner K is a small pipe for assisting the vacuum in the heating chambers of the second and third sections by clearing them of surplus air.

DETAILS OF APPARATUS.

The boiling chamber of each section is simply a cast iron cylinder, of larger diameter than the heating chamber beneath it. The object of the increased diameter is to enable the chamber to contain a large quantity of brine with a minimum of depth and a maximum of evaporating surface. The usual level of the brine is seen in the first section, which in fact is a sectional view of a single apparatus, the second and third sections being shown in elevation. The heating chamber consists of a series of conical tubes of comparatively small diameter surrounding a central tube of larger diameter, as shown in the horizontal section at Fig. 2. The whole of the tubes are inserted in a tube plate at top and bottom, and inclosed in a cylindrical chamber, into which steam is admitted in the first section by the pipe, E, and after imparting its heat to the brine it is condensed, and passes away to a steam trap as shown. In the second and third sections, the condensed water is drawn off by pumps. The reason for having the tubes conical is to prevent scaling, or, should scaling take place, that it may be easily removed, the larger diameter of the tubes being at the bottom. The author's experience of the working of the system, however, leads him to believe that scaling will not take place, so moderate is the heat applied, so rapid the circulation of the brine, and so powerful the ebullition maintained. It is to promote and increase the rapidity of the circulation that the central enlarged tube is employed. In operation, the brine heated by the small tubes passes upward through them to the boiling chamber. It then makes for the center, and returns downward through the large central tube by reason of the lower temperature prevailing within that tube. The proportion of the volume of brine to the heating surface being much greater in the large tube than in the smaller tubes causes a reduced temperature within it, and the rapidity of the circulation is thereby increased in accordance with the natural law that heated fluids or gases ascend, while those of a lower temperature descend.

The settling chamber, immediately beneath the heating chamber, serves for collecting the salt as it is precipitated. It settles readily, as no movement takes place in the brine at that point. It is, of course, in direct communication with the upper or boiling chamber through the tubes of the heating chamber. This collecting chamber terminates in a sluice valve, and is in this way connected with the vacuum filter beneath it, which forms an important and essential feature of Dr. Pick's system. Each filter consists of an upper fixed portion and a lower hinged portion, the filtering medium being attached to the lower portion of the filter at its junction with the upper part. The upper part is fitted with an air inlet cock and a water pipe, ending in a rose for washing the salt if necessary. The lower part of the filter is connected with the boiling chamber by a tube, the lower portion of which, as far up as the valve, is flexible, and yields when the filter is opened, as will be seen from the dotted lines in Fig. 1.

METHOD OF WORKING.

The method of operating Dr. Pick's system is briefly as follows: Each of the three sections having been charged with brine to the proper level, which is that indicated in the boiling chamber, A, steam is admitted to the heating chamber of the first section, in which the highest temperature is maintained. The brine in that section becomes quickly heated, and the steam given off from that brine enters the heating chamber of the second section, heating the brine in that section. The steam given off from the brine in the first section, after doing its work in the heating chamber of the second section, condenses and produces a vacuum in the boiling chamber of the first section, which vacuum is aided, if necessary, by opening the valve on the connection with the vacuum pump. The pressure being reduced, the brine in the first chamber enters into violent ebullition at a comparatively low temperature. The same process is repeated in the second section, the steam chamber of the third section acting as a condenser, and producing a vacuum in the boiling chamber of the second section. The steam generated in the third section is drawn off by the vacuum pump, and condensed by the jet condenser as shown. It will be seen that the highest vacuum and the lowest temperature exist in the third section, while the highest temperature and the lowest vacuum occur in the first section. As the salt is precipitated it settles in the collecting chamber, and at stated intervals the sluice valve is opened and the salt and brine are admitted into the filtering chamber. After settling there for a few seconds, the sluice valve is closed and the air cock on the filter is opened. The valve on the ascension pipe, H, is then opened, and in a few seconds more the whole of the brine in which the salt lies as in a bath is automatically transferred to the vacuum chamber, leaving the charge of salt resting on the filtering medium and perfectly free from brine. The valve on the ascension pipe is then closed, the filter opened, and the charge withdrawn. The filter is then closed ready for another charge of salt.

It will be observed that, during the operation of letting down the charge of salt and withdrawing it from the vacuum filter, it is not necessary to stop working, the processes of evaporation and production being thus rendered simultaneous and continuous, and, above all, automatic. It was by devising this system of communication between the lower and the upper portions of each section that Dr. Pick was enabled to solve the problem of practically and profitably evaporating brine in vacuo. It is the vacuum filter that gives the finishing touch to the triple effect system in the present connection, and to Dr. Pick belongs the credit of being the first to succeed, by means of an ingenious but simple arrangement, in utilizing the vacuum system for the manufacture of salt.

WORKING RESULTS.

The author has hiterto been dealing with a complete apparatus consisting of three sections. The successful working of the Pick system, however, does not depend upon the use of three sections, inasmuch as the finest salt has been and is still being made equally well in one section, although of course not nearly so economically as if the complete set of three was adopted. In order to demonstrate the practical value of Dr. Pick's invention in England—for it had previously been proved in Austria—a single section, with its air pump and condenser, was erected in the early part of the present year at the Shirleywich salt works, Staffordshire, under the author's supervision. This plant has now been running for several months with thorough practical success as a salt producer. Steam is supplied to the heating chamber of the apparatus from an eight horse portable engine, which also drives the vacuum pump and jet condenser. It is only a small plant, capable of turning out about one ton of salt per day of 24 hours from saturated brine, *i. e.*, brine containing 2 lb. 6 oz. of salt per gallon, but this it does regularly.

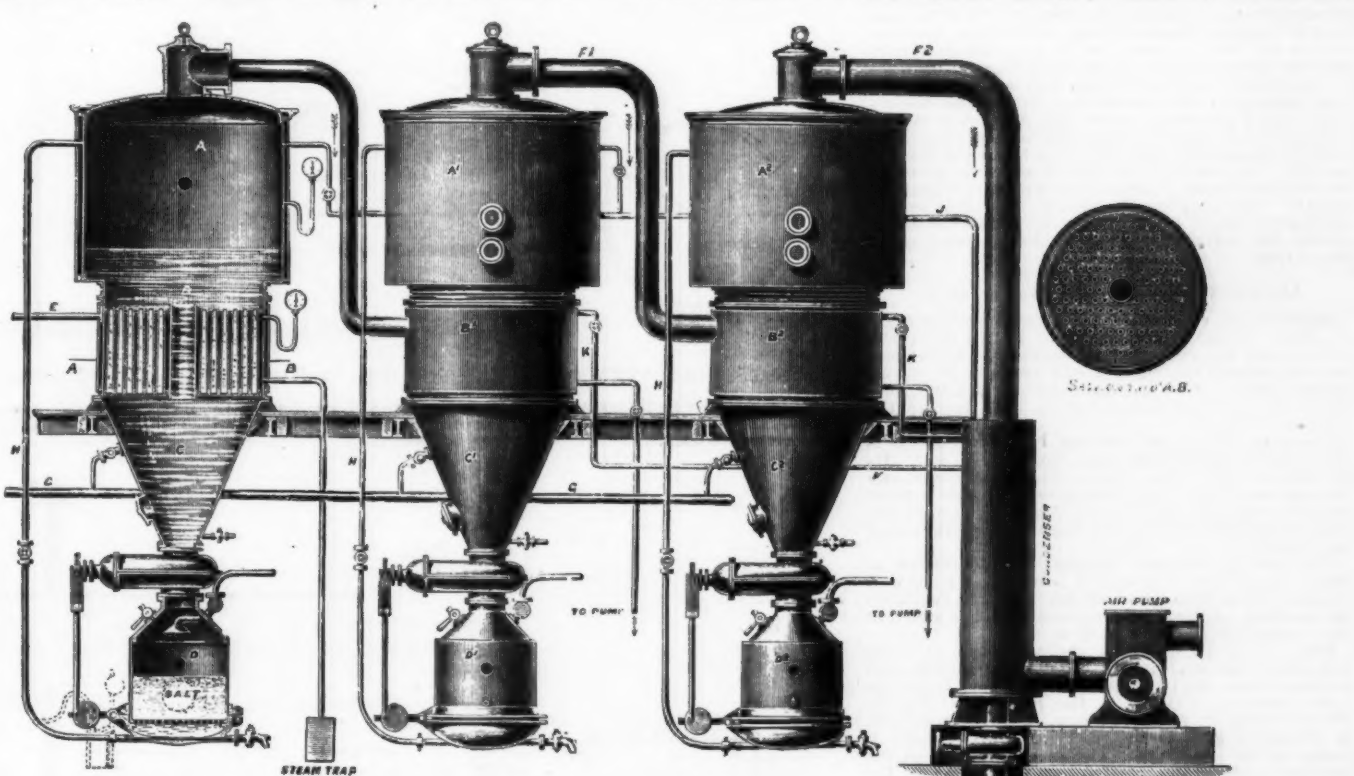
In fact, of late, and since the apparatus settled itself down into steady working order, it has on many occasions exceeded this output. A charge of salt weighing about 1 cwt. is drawn every hour without stopping the apparatus, and samples of the salt thus produced lie on the table for inspection. It will be seen that the salt is of the finest quality, and it is a noteworthy fact that the density of the salt produced by Dr. Pick's apparatus at Shirleywich is just double that of the salt produced at the same works, and from the same brine, by the ordinary open pan process. This will be seen from the samples, inasmuch as the three inch cubes of Pick's salt weigh 21 oz., while the three inch cubes of open pan salt weigh only 10½ oz., or just half.

COST OF PRODUCTION.

So far as the working of Dr. Pick's system both in Austria and at Shirleywich has gone, it has proved, in all respects, thoroughly satisfactory and has amply demonstrated that the best and finest salt can be expeditiously and economically produced by it. Although it has not been possible in the special circumstances under which the apparatus was put up and worked for the author to ascertain the cost of production, he is perfectly satisfied that, in practice, it will be very much less than that of the ordinary salt pan system.

ADVANTAGES.

The practical advantages of Dr. Pick's system have, in the author's opinion, been fully established by the working of the apparatus at Shirleywich. It has shown (1) that a large saving of fuel is effected by it as against the ordinary salt pan process. (2) That the space required for turning out a given quantity of salt is very considerably less than that required for an ordinary salt pan plant capable of turning out a corresponding quantity. A plant capable of producing 50 tons per day will only occupy an area about equal to that covered by a salt pan producing 40 tons per week. (3) That the cost of labor is reduced to a minimum, the apparatus being very simple in construction and practically automatic in action and not requiring special supervision. (4) That the cost of maintenance will be very small, there being no plates to scale and burn out as in the ordinary salt pan. With regard to scaling the author would observe that he had the apparatus opened after several weeks' continuous working and found the tubes and all other internal parts bright and clean, and perfectly free from any sign of scale. (5) That as the brine nowhere comes in contact with fire, no acid vapors can be formed and given off as in the ordinary process, so that there is an entire absence of those noxious gases which are prejudicial alike to animal and vegetable life. The opinion of the author is that Dr. Pick has succeeded in effecting an important improvement in the manufacture of salt by means of a system which cannot fail to prove both economical and effective.



IMPROVED APPARATUS FOR THE MANUFACTURE OF SALT IN VACUO.

These views are indorsed by practical salt makers and by some of the leading scientific authorities on the subject. Sir Henry Roscoe, F.R.S., after inspecting the process, states in a report upon it that it is founded on sound scientific principles; that it is automatic and continuous, and is a great improvement on the old process. Mr. Alfred E. Fletcher, H. M. Chief Inspector under the Alkali, etc., Works Regulation Act, who has officially inspected the apparatus at Shirleywich, states that Dr. Pick's system, if adopted for the manufacture of salt, will be a means of removing the great nuisance now arising from the emission of black smoke and from the corrosive vapors now discharged so copiously from the fires under salt pans. He also observes, in his report, that the change of system will effect a great improvement in the condition of the workpeople employed. On these grounds he says he anticipates great public benefit from the introduction of the system.

CONCLUSION.

From the experience gained with the present limited plant, the author thinks he has fairly shown that Dr. Pick has succeeded in placing within the reach of the salt industry a factor which, by materially reducing the cost of production, must benefit the manufacturer, and should in turn benefit the consumer. But this is not all. There is yet another and a broader aspect in which the new process may be viewed with advantage, and that is a national one. Notwithstanding the combination known as the Salt Union, which was formed about two years since, the salt manufacture in England looks at present very much like a departing industry. In support of this statement, the author may mention that whereas in 1888 there were 898,671 tons of salt shipped from this country, the shipments during 1889 fell to 666,796 tons, a decrease in one year of 231,875 tons, or, in other words, a loss of more than one-fourth of the export trade in salt. When it is remembered, too, that the exports of chemicals from this country, in the manufacture of which salt constitutes one of the principal items, stand at present at £2,000,000 per annum, it becomes apparent that, but for the introduction of Dr. Pick's process, or of some other equally efficient system, it may be expected that the decrease in the export of salt shown last year will be repeated, if not exceeded. The perfecting of his system has occupied Dr. Pick several years, and it seems as though he had brought his investigations to a practical issue at a very important juncture in the history of the salt industry. Let us hope that, by the aid of the new process, England may regain and retain that which appears to be slipping from her grasp. Should it help to accomplish this, it would materially add to the credit already due to Dr. Pick in respect of the present invention.—*Iron.*

LIGHTING BY COMPRESSED GAS.

LIGHTING by compressed gas is based upon the use of *oil* gas, the only luminous agent known up to the present that can be stored up, through compression, under a reduced volume and still preserve its illuminating power for an indefinite period, and the combustion of which produces no resins that stop up the burners.

The illuminating power of non-compressed oil gas is four or five times greater than that of coal gas. Its quality, it is true, depends upon the oil employed and the care used in its manufacture, especially as regards the temperature of distillation. Compression produces but a slight diminutionjin the illuminating power—say one-eighth.

This gas is obtained through the distillation of heavy oils of schist, boghead or petroleum residue at a temperature of from 700 to 800 degrees. The vegetable oils likewise, by the same treatment, yield a gas that may be used for the same purpose.

Figs. 1, 2, and 3 represent the installation of a five inch retort furnace, with the accessory apparatus and a compression pump. The oil, which constitutes the prime material, is stored in the reservoir, O (Fig. 1), whence it is sent by a hand pump, R, to the reservoir, Q, whence it goes to the retort, U (Fig. 3), which is heated by the furnace, A. The gas derived from the distillation leaves the greater part of its tar in the box, C. A pipe provided with a valve, D, leads the gas into the condenser, E, which it first traverses from top to bottom and then from bottom to top. Upon its exit from the condenser, the gas goes to the purifier, F, and thence, after traversing the meter, G, to the gasholder, I.

In order to compress the gas, the steam pump, H, sucks it through the drier, J, and forces it either into the accumulator of the works, if there is one, or into the charging receiver, which is put in communication with the mouth, L.

P is a pit, into which runs the tar deposited by the gas in the tar box, condensed and purified. K is a cock for the removal of the hydrocarburets.

Works like the one represented are capable of producing from 700 to 875 cubic feet of compressed gas per day.

In order to produce 3,500 cubic feet of gas, it requires:

400 lb. of oil;
495 lb. of coke;
385 lb. of coal;
18 cubic feet of wood;
6 lb. of lime;
¼ lb. of lubricating oil;
½ lb. of rags.

The price per cubic foot depends upon the price of the materials and the cost of manual labor.

LIGHTING OF MARITIME APPARATUS.

We shall now examine the application of compressed gas to the lighting of marine installations.

The gas prepared at the works must first be carried to the place where it is to be used. This is done by means of receivers provided with pressure gauges, and in which the gas is compressed to 1,450 lb. to the square inch. In order to make the maneuvering easier, reservoirs having a capacity of but 70 or 100 cubic feet are generally used. If the gas is destined for a work situated out at sea, the reservoirs are stowed away upon a boat. When there are quite a number of buoys, etc., to be supplied, it is preferable to select a special boat for the service. The reservoirs are then installed permanently and connected by piping with a distributer that permits the superintendent of the service, at the moment of filling the reservoir of the buoy or floating light, to take gas from the accumulator, which is under the proper pressure.

The maritime apparatus lighted with oil gas are of four kinds: buoys, floating lights, beacons and light-houses.

Buoys.—In buoys, the shell serves as a float and as a reservoir for the compressed gas.

This shell, in order that it may be adapted to meet the various conditions under which buoys are installed, must necessarily vary in form; but, whatever be its form, the buoy is of welded iron plate and without rivets, save in spherical buoys. In this way perfect tightness is obtained.

A portion of the buoys employed is manufactured at the Saint Chamond Works, which exhibited a model of them in the machinery gallery of the exposition of 1889.

The plates, which are first stamped to the desired form, are connected with each other by means of small temporary rivets spaced 20 or 24 inches apart. The parts thus put together are placed over a fire and the welding is begun. The welding is done iron to iron

Fig. 1.

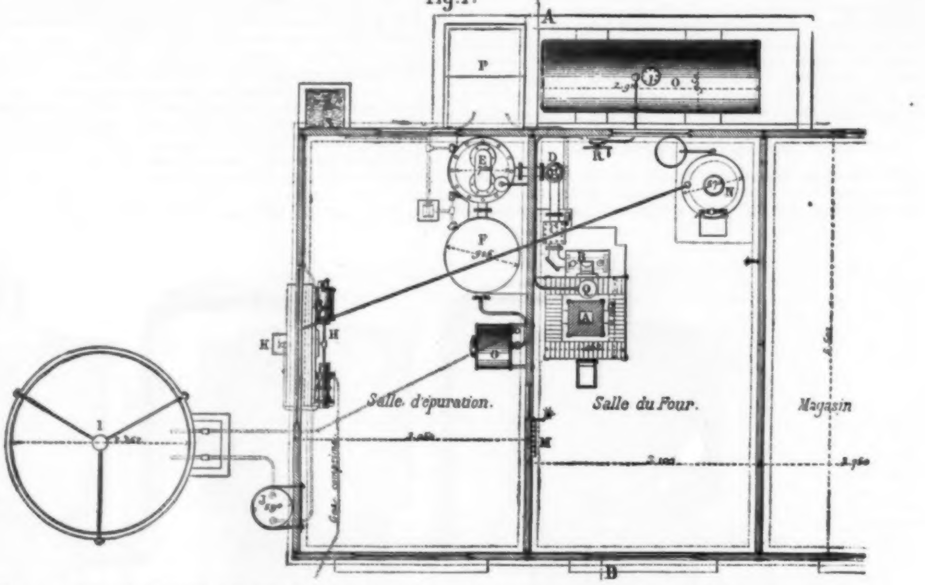


FIG. 1.—PLAN VIEW OF WORKS FOR THE MANUFACTURE OF COMPRESSED GAS.

A, furnace; B, hydraulic main; C, tar box; D, valve; N, generator; R, oil pump; M, pressure gauge; E, condenser; F, purifier; G, meter; H, compression pump; O, oil reservoir; P, tar pit; I, gas holder; J, drier; K, clearance cock.

Fig. 2.

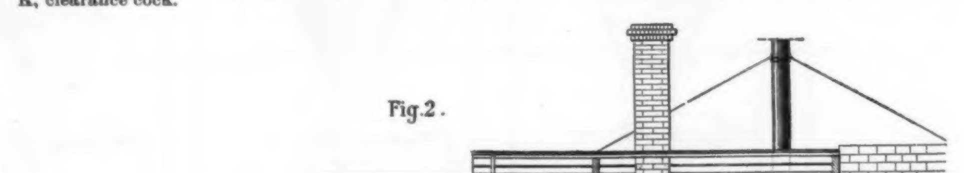


FIG. 2.—ELEVATION OF THE WORKS.

LIGHTING BY COMPRESSED OIL GAS.

without the interposition of any foreign material. In this way, perfectly tight buoys can be made; it merely suffices to form a half inch aperture for the escape of the gases produced under the influence of the heat.

Conical buoys, a specimen of which is represented in Fig. 4, are to be preferred when the depth of the water permits of their use. The tail, which terminates in a very heavy counterpoise, has the same effect as the keel of the ship and secures stability. On another hand, as the part that emerges is conical, it offers but little purchase to waves and the wind. The oscillations when the sea is rough are consequently much reduced, and the visibility of the light remains more constant. All buoys of large dimensions are of this type.

The largest ones that have so far been constructed have a capacity of 595 cubic feet, a draught of 23 feet, and a height of flame of 22 feet above the water line. The smallest model has a capacity of 88 cubic feet, a draught of 10 feet, and a height of flame of 11 feet.

Cylindrical buoys (Fig. 5) have also a tail, but the part that emerges is cylindrical instead of conical. They possess the same qualities as the preceding, but to a less degree. They have the advantage of being more easily constructed and, consequently, of costing less.

Double case buoys, held either by a balance (Fig. 6) or by a collar fixed above the counterpoise, may be anchored in shallow water without danger of sometimes touching bottom.

Spherical or re-entrant bottom buoys (Fig. 7) can be grounded without inconvenience. The Suez company has adopted them for the beaconing of its canal. They can be placed high and dry upon the banks or upon the sand bars that they are designed to give warning against.

The buoy lanterns have glasses of 8 inch (Fig. 8) or 12 inch focus. A notable improvement has recently been made in the burners. Formerly the flame was formed of the union of three or five Manchester burners. This arrangement rendered the regulation very difficult, and the intensity obtained with a definite discharge was feeble and irregular. Now the burner is formed of a steatite crown, giving an equal flame throughout its entire circumference.

The air (whose course is shown by the arrows) is led into the interior of this crown and then directed to the exterior by a metal cone. It is thus forcibly put in contact with all parts of the flame. The gas therefore burns under the best of conditions and the intensity of the flame is much increased. The disk that surmounts the crown contributes to this result and widens the upper part of the flame, so that it is much less obscured by the chimney and the foot of the burner.

For a consumption of less than 4,880 cubic in., one carcel is obtained with an output of 2,400 cubic inches per burner. This diminishes in proportion as the discharge increases, and is reduced to less than 1,500 cubic inches for burners with several crowns consuming 15,300 cubic inches and giving 10½ carcels.

The choice between the 8 and 12 inch glasses depends upon the intensity to be obtained. The 8 inch apparatus give no more than 7½ carcels, while the 12 inch ones give as many as 16 or 17. As the consumption of the latter is greater and the weight of the lantern is greater too, buoys designed to receive the 12 inch lantern will be at least of 260 cubic feet.

The buoys may be characterized by the color of the

flame or by making the latter flash. This is effected by means of an apparatus that acts automatically through the pressure of the gas upon its exit from the regulator. Finally, there is nothing to prevent the buoy from being made sonorous as well as luminous.

Floating Lights.—Here, reservoirs arranged in the hold of a ponton furnish the gas necessary to supply the burner.

These floating lights can thus be established without a crew. They possess the two following advantages over those lighted with oil: (1) they give a greater intensity of light; and (2), being much lighter apparatus than the oil ones, they can be kept at their normal height during stormy weather and thus have a constant range. Moreover, in most cases, a floating light can be advantageously replaced with two large buoys.

Beacons and Lighthouses.—It may be of great interest to establish a light upon a sand bar or a rock at sea or upon a site difficult of access. An installation lighted with gas will be the most advantageous in such cases, since it will permit of simplifying the construction (which will not have to be provided with living apartments), and of saving in the salaries of keepers.

The beacons receive the same lanterns as the buoys. There has also been constructed a 15 inch lantern that permits of using burners of a greater discharge (about

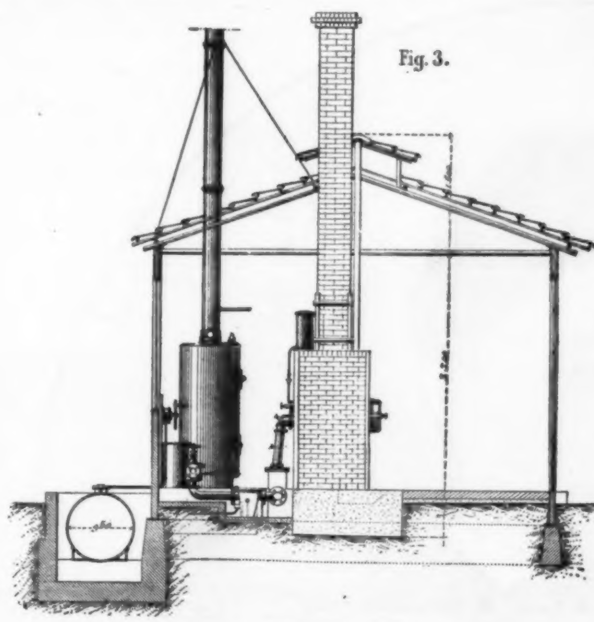


FIG. 3.—SECTION ON A B.

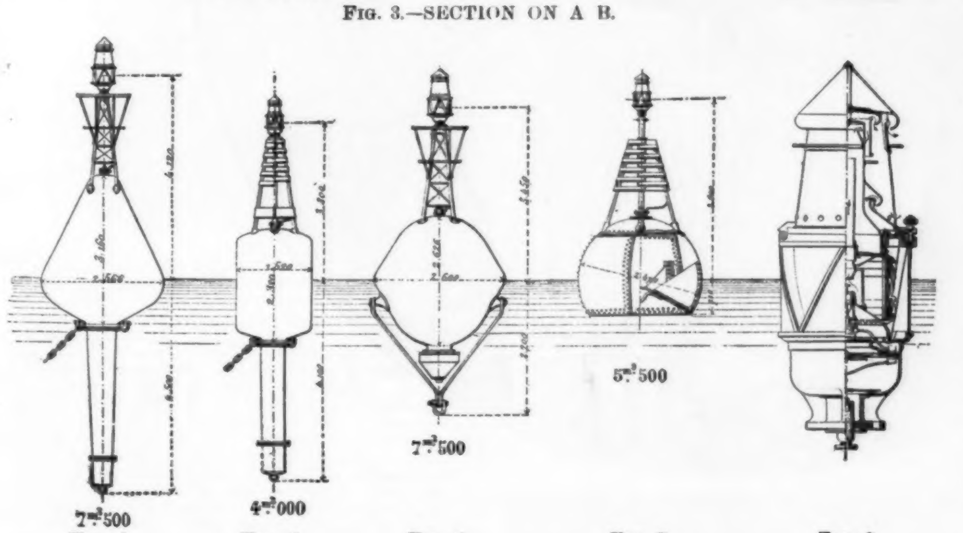


FIG. 4. FIG. 5. FIG. 6. FIG. 7. FIG. 8.

FIG. 4.—Conical Buoy. FIG. 5.—Cylindrical Buoy. FIG. 6.—Double Cone Buoy. FIG. 7.—Spherical Buoy. FIG. 8.—Lantern with 8 inch Apparatus.

LIGHTING BY COMPRESSED OIL GAS.

15,000 cubic inches), with which an intensity of from 140 to 150 carcels may be reached.

Finally, let us add that gas may be substituted for oil in the present lighthouses of all kinds, without any modification being made in the existing apparatus than the introduction of the air necessary to supply the burner and for the expulsion of the products of combustion.

In order to give an idea of all the applications of compressed gas now current, it would remain for us to speak of its application to railway cars, but this is so well known that it seems to us useless to describe it. It will suffice to recall that there are two principal types of installations.

The first of these, with reservoirs fixed to the frame, under the body of the car, is used by almost all companies. The second, which is used for the Paris, Lyons and Mediterranean Railway, differs from the first in the arrangement of the reservoirs, which are supported by the roof of the cars.

Notable improvements have been made in the lanterns.

These are usually provided with intensive lamps that offer the triple advantage of reducing the consumption, of consequently diminishing the capacity to be given to the reservoirs, and, with their reduced discharge, of giving a notably intenser light.—*Le Genie Civil.*

SOME PRACTICAL BUSINESS APPLICATIONS OF THE MICROSCOPE.

By Dr. FREDERICK GAERTNER, Pittsburg, Pa.

THE man who has learned the use of the microscope has certainly gained a great deal, but the man who claims to be a scientist without knowing the practical value of the microscope and without having learned its use ought not to be classed as such. The microscope when first invented was considered as an accessory or a plaything. But since 1820 and later (1840) the first European oculists and scientists began to make microscopical researches, not only in the medical profession, but also in botanical, geological, and other studies. Since 1860 and 1870, the world over, the microscope has been applied to almost every study and analysis. Had Galen, Celsus, and Hippocrates, and other ancients, had the use of the microscope, they would not have advocated the theory that the arteries in the human being contained air during life, instead of oxygenized blood. They were of the erroneous opinion that the blood simply acted as a humor in lubricating the tissues. Had it not been for the microscope, James Paget, the great English surgeon and physician of St. Bartholomew's Hospital, in the year 1834, would not have discovered the *Trichina spiralis*, which had already slaughtered its thousands, dating as far back as the time of Moses.

The microscope is certainly the greatest aid a scientific and a professional man can have. A physician without a microscope is like a man without his hands; he is uncertain and unprotected. He cannot arrive at a correct and positive conclusion in diagnosing and prognosing his cases. It is important to have the microscope at hand for examining the sputa of human beings, so as to be able to state positively whether or not the man is suffering with consumption (tuberculosis). It is important to be able to determine with a certainty, at an early date, whether or not a man is suffering with cancer of the stomach by examining the vomits. A microscope magnifying from 1 to 5,000 diameters is a most simple piece of apparatus. Every person can learn its use in a few hours. Every person should learn to use a microscope, not only the professional man and scientist, but every business man, even the grocer, butcher, farmer, and the housewife.

Everything that concerns a medical examination in a legal sense, or a legal examination in a medical sense, can be determined accurately by the use of the microscope. For example, in the Cronin case of Chicago, where the medical experts demonstrated to a certainty that the blood, hair, and brain matter found in the Carlson cottage and sewer trap were those of a human body. Not only that, but they determined accurately and positively that the hair and blood found in the cottage and in the fatal trunk were those of Dr. Cronin, only in a modified condition; all with the aid of the microscope.

Within the last decade scientists have demonstrated to a certainty the possibility of determining dried and old human blood-spots from those of animal blood, whether on clothing, wood, iron, or otherwise.

Pathologists and histologists have also demonstrated the great value of the microscope in determining positively the skin, hair, blood, brain matter, also the excretions and secretions of the human being from those of the lower animals.

Again, the microscope is applied in a medico-legal view, especially in malpractice, suits of damages, suits involving rather than determining the adulteration of foods and drink as to their purity, and finally in determining whether or not food or drink has spoiled, undergone fermentation and the accumulation and development of micro-organisms, such as germs, microbes, and bacilli. Also, in the examination of oleomargarine and in the adulteration of drugs, liquors, milk, groceries, sausages, etc.

The application of the microscope in a legal point of view is altogether new. We anticipate surprising effects from the application of the microscope in the examination of legal documents, U. S. currency, and printed matter.

The following lines are from a very ample paper read by G. E. Fell, M.D., before the American Society of Microscopists, entitled: "Examination of Legal Documents with the Microscope."

More than once has investigation with the microscope cleared up the path of the attorney, ferreted out the work of the contract falsifier, and shielded the innocent from the unjust accusations of interested rogues.

The range of observation in investigations of written documents with the microscope is a broad one. We may begin with the characteristics of the paper upon which the writing is made, which may enable us to ascertain many facts of importance for instance, a great similarity might indicate, with associated facts, that the documents were prepared at about the same time. A marked dissimilarity might also have an important bearing upon the case.

The differences in the paper may exist in the character of the fibers composing it, the finish of the surface, whether rough or smooth, the thickness, modifying the transmissibility of light, and the color, all of which may be ascertained with the microscope.

The ink used in the writing may be examined. If additions have been made to the document within a reasonable time of its execution, it is well to examine it microscopically with a great probability of detecting the differences of the original and additional inks. These differences may be present, as follows: Some inks in drying assume a dull or shiny surface. If in sufficient quantity, the surface may become cracked, presenting, when magnified, an appearance quite similar, but of a different color, to that of the dried bottom of a clayey pond after the sun has baked it for a few days. The manner in which the ink is distributed upon the paper, whether it forms an even, somewhat regular, border or spreads out to some extent, are factors which may also be noted. The color of the ink, by transmitted or reflected illumination, is a very important factor. This, in one case, proved of great importance, and demonstrated the addition of certain words, which completely annulled the value of the document, involving several thousand dollars. And in a case where the lines of a document were written over with the idea of entirely covering the first written words, the different colors of the ink were concealed from the magnified image as seen under reasonably low powers of the microscope.

Special attention is desired to the examination with the microscope of written documents, United States currency, printed matter, etc., as to their genuineness from a legal standpoint. The principal feature in the examination of written and printed documents is in the erasures and the additions, in the different coloring of different inks applied, and the mode of their execution.

Erasures can be accomplished either with a knife or by a chemical preparation. The former process is the one commonly resorted to, and is effected in the following manner: With a well sharpened knife-blade the surface of the paper is carefully scraped until all objectionable lettering and wording is supposed by the naked eye to have disappeared. With a microscopical examination you can at once detect the impression made by the stroke of a pen. Even the different colors of the ink are still to be seen with the microscope.

The second method is by a chemical preparation. The ink is made soluble and then easily removed from the paper by means of a blotter or absorbent cotton. This method is also an incomplete one, and the letters can easily be made out by close observation, where a chemical preparation has been used for erasing. In most cases it leaves a stain, and the fibers of the paper are more or less injured by the chemicals used, always leaving evidence that the document has been tampered with.

Geo. E. Fell, in his paper, says the eye of the individual making the erasure is certainly not sufficient, and even with the aid of a hand magnifier the object might not be effectually accomplished. The detection of an erasure made by the knife is a very simple matter, and may be accomplished by the novice. An investigation may be made by simply holding the document before a strong light, and this is usually all that is necessary to demonstrate the existence of an erasure of any consequence. This is, however, a very different matter from making out the outlines of a word or detecting the general arrangement of the fibers of the paper, so as to be enabled to state whether writing has been executed on certain parts of the document. Again, when we enter into the minutiæ of the subject, we find that the compound microscope will give us results not to be obtained by the simple hand magnifier.

On several occasions I have had the opportunity of

demonstrating with the microscope additions made to certain documents, two of which were wills. The additions were made in the following manner (which the microscope revealed): First, an erasure must have been produced, then there was a writing over the erasure. With the microscope you could at once detect the erasures and the additions; also the different colors of the inks used, and, next, the most important characteristic of the microscopical examination being in the close observation of the stroke of the pen of the original lettering and the additional lettering, and, finally, the general mode of their execution.

In the examination of legal documents, U. S. currency, printed and mutilated documents, including forgeries, etc., involving a legal question and investigation, the principal features in the microscopical examination as already stated are the erasures, additions, color of the ink, stroke of the pen in the original lettering and additional lettering, and, finally, the mode of their execution. This includes the general and comparative expression of the original writing, that is, in the observation of the letters constituting the document. Especial attention is needed in the observation of the shading, and in the general formation of the letters by the stroke of the pen either in a downward or upward movement. This applies not only to the capital letters, but also to the smaller letters, even to the punctuation, grammatical and orthographical relationship, and in comparative differentiation. All these things must be taken into consideration.

In the examination of papers, documents, such as wills, notes, checks, etc., as to whether or not they were mulitated and forged, the microscope will certainly be the most reliable test, much the easiest and simplest.

This is the way of determination, and an expert microscopist and observer can at once arrive at a correct and positive conclusion as to the genuineness of the autograph, etc.

In the examination of U. S. currency the same will hold good as in the examination of written and printed matter, with the exception that additional observation is necessary in order to differentiate a genuine bill from a counterfeit. This lies in the microscopical examination (1) of the quality of the paper used; (2) in the execution and finish of the bill; (3) the grade and color of the ink; (4) the printed condition of the bill, including the autograph; (5) the most important and characteristic means of determining a genuine bill from a counterfeit bill being in the observation of the red line which runs lengthwise across the bill, and it will be necessary to notice that the two red lines in a genuine bill are simply red silk thread interwoven in the paper of the bill, when in a counterfeit the red lines are simply red ink stripes, and no silk lines whatever.—*Microscopical Journal.*

Paste Eels.—It may not be generally known that vinegar eels and paste eels are identical, the greater vigor of the latter being due to the more nutrient qualities of the paste.—*The Observer.*

MISS FAWCETT.

The advocates of the higher education of women—or rather of their admission, equally with men, to the more arduous studies and intellectual exercises which are supposed to be part of education—have great cause to exult in the Class List of the Cambridge Mathematical Tripos, which was recently published at the Senate House of that University. Miss Philippa Garrett Fawcett, of Newnham College, was placed by the examiners above the senior wrangler of the year; implying that if she had been a member of the University, and so entitled to official recognition, it would have been their duty to pronounce her senior wrangler. At present the women students who reside either at Girton or Newnham College have, strictly speaking, no connection with the University of Cambridge, and it is only through the courtesy of the Senate that the examiners are allowed to set them the same papers as the men, and to announce what places they would have occupied had they been entitled to take academical rank. In spite, however, of this grudging and inconsistent attitude on the part of the University authorities, the male portion of the University students, in the case of Miss Fawcett, seem proud of the success she has won, as is evident from the heartiness of the reception accorded to her in the Senate House. When her name was read out prefaced by the words "above the senior wrangler," the enthusiasm of the undergraduates was unbounded, showing that the jealousy with which men are sometimes declared to regard learning in a woman has no place at Cambridge. It will be remembered that, three years ago, another lady, Miss Agneta Ramsay, now wife of the Master of Trinity, Vice Chancellor of the University, won the distinction of senior classic at this University.

Miss Fawcett is the only daughter of that estimable public man, the late Right Hon. Henry Fawcett, M.P., Postmaster General, Professor of Political Economy at Cambridge, and of his wife, who was Miss Millicent Garrett, sister to Mrs. Garrett Anderson, M.D., and who has written valuable treatises on subjects of political and social science. The portrait of Miss Fawcett is from a photograph.—*Ill. London News.*

MISS FAWCETT, OF CAMBRIDGE UNIVERSITY.

INCREASE OF LOCOMOTIVE TRACTION BY MEANS OF ELECTRICITY.

At the recent meeting of the Association of Railway Telegraph Superintendents, at Niagara Falls, N. Y., Mr. Charles Selden read a paper upon the increased adhesion between the wheels of a locomotive and the track caused by the passage of electricity.

From competent authorities on motive power, it has been determined that a locomotive having a weight of 100,000 pounds has a tractive power upon the rail, when in best condition, of but 25,000 pounds. And when the rail, by reason of the weather, is in a bad condition, the tractive power amounts to only about what an engine of 15,000 pounds weight should have. In other words, on good rail, by non-adhesion, the locomotive gives but twenty five per cent., and on bad rail but eighteen per cent. of the power which, theoretically, should be had from it.

Efforts were made some fifteen years ago by an Englishman named Werderman to overcome the non-adhesion, by winding the spokes of the driving wheels with wire, thus making a magnet of the wheel, with the view of attracting the wheel to the rail by magnetism, thus increasing the friction, and, thereby, the adhesion to the rail on the part of the locomotive. Having but a primary battery, it is plainly to be seen that the results were so slight as not to be appreciable. Another objection, even had the dynamo been used, was that, in order to secure sufficient magnetism to be of benefit upon such an immense machine as a locomotive, the magnets would have to be very large, and the winding upon the spokes of the drivers would have necessitated a change in the construction of the engine, so that as the bobbin was being revolved by the wheels there would be room to clear the firebox on the inside and the side rods of the locomotive on the outside. This, of course, would render necessary a longer crank pin for the bars, and, being longer, it must necessarily be stouter in order to stand the increased leverage, so that a device of this character for the locomotive engine would not be economical, and would necessitate the reconstruction of all locomotives using it. This inventor filed patents in this country, and several others followed in his footsteps, but nothing practical has yet been evolved from that method.

Mr. Elias E. Ries has taken a wide departure from the path pursued by former inventors. Mr. Ries proceeded upon the hypothesis that an electric current of large volume, if properly employed, could be used to weld metals. Acting upon this theory, he proposes to arrange upon a locomotive a dynamo of sufficient power, to be run by a small auxiliary engine, and to pass the current from the dynamo to the driving wheel of the engine, along the rail to the next driving wheel, through its axle and the other wheel to the other rail and back to the first driver, thence to the dynamo; thus making a local circuit, so to speak, which would travel with the locomotive, passing a current through the drivers and along the rail as indicated; and for this purpose, by a very simple method, he insulates one pair of the driving wheels. By this means the inventor proposes to cause an incipient weld between the driving wheels and the rails. I say incipient because, the wheels being in motion, the weld, if any, is being made and broken by the revolution of the wheels; therefore, a perfect weld is not obtained; nor, of course, would it be desirable except for brake purposes, as in descending a grade for instance.

If the theory advanced by Mr. Ries can be made a success practically, it means a great many things to the railroad world. If, by means of this invention, the tractive power of a locomotive is increased, say even twenty-five per cent., it means ten additional cars on a forty-car train. It means a large gain in the hauling capacity on high grade railroads; it means increased speed for passenger trains; it means a saving, indirectly, of fuel; it means the employment of lighter loco-

motives to do the same amount of work as the heavier ones, thus being easier on the roadbed and bridges, and the mounting of grades that would not be considered possible at the present time. All this, provided that in practice on a locomotive the theories advanced shall hold good.

Another feature of this invention is that it is not necessary to keep the current flowing all the time unless you need it, but when you stop the train and want to start it, your locomotive at that time not being in motion, a more perfect weld is obtained, thus enabling you to start at once without slipping, and after you have gotten your train under headway, your current, if desired, may be switched off; so much for the pulling power and so much for the motor.

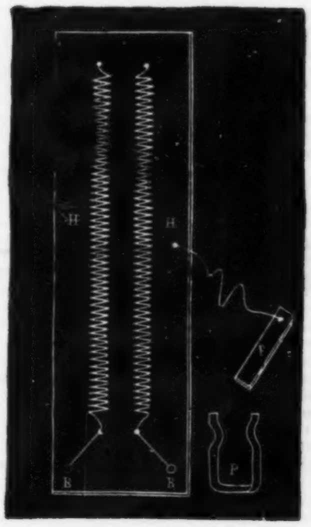
The statements made by Mr. Selden were questioned by Mr. Nichols, and a model motor and track were introduced to prove the assertions claimed by the inventor. The experiments made were entirely satisfactory and convincing to the most skeptical—the only question being as to the practicability and economy of the application on a large scale.

A VERY SIMPLE RHEOSTAT.

IN the current applications of electricity, there is often need of graduating the intensity by the interposition of resistances in the circuit. Such is the case, for example, when it comes to regulating the light of an incandescent lamp.

Here is a rheostat that any one can construct for himself at slight expense.

Upon a board, A, mount two German silver spiral springs, HH'. These may be easily made by winding the wire around a cylindrical stick. Care must be taken, however, to have the wire of the same length for each helix and to have the spirals as close together as possible. They may afterward be separated, if necessary, by stretching the spring upon the board. The spring should be so fixed to the latter as to leave a space of ¼ of an inch. It is unnecessary to say that the length and section of the wire should be selected according to the resistance needed and to the maximum intensity of the current that is to traverse the apparatus. In any event, the wire should not be allowed to become hot enough to give rise to superficial oxidation. Communication with the apparatus is established by means of two



terminals, B B'. The two helices are put in communication at a height that varies according to the resistance that it is desired to interpose. This is done by means of a strip of metal, P, which is simply placed between the spirals.

It will be remarked that the contact thus obtained is excellent, because, at the moment of the introduction of P, a friction occurs that cleans the surfaces.

The figure shows, at *p*, the position of the strip interposed between the spirals. If the current has a dangerous tension, it will evidently be necessary to provide the strip with an insulating handle.

The apparatus at the same time forms an interrupter. By taking away the strip, P, the circuit is broken. As this thing occurs every time P is displaced, it is necessary, if we wish to change the resistance without interrupting the current, to make use of two strips, which are to be displaced in succession. Again, in such a case, the strip, P, may be replaced by a spring clip, P', which is simply slipped between the helices.—*La Science en Famille.*

BERTRAND'S AUTOMATONS AND PUPPETS.

THE construction of automatons has always excited interest and curiosity. The information that we find on this subject in ancient authors is quite confused, it is true. We may mention especially the wooden dove of the Greek mechanic Archytos, spoken of by Aulus Gellius. At a more recent epoch, Kircher, Portar, Scott, and Solomon de Caus, in their remarkable works, give us a description of automatons that drank or that played music. Vaucason's mechanical pieces have remained celebrated, and the visitor to the gallery of the Conservatory of Arts and Trades can still gaze with wonder at a magnificent doll of this celebrated mechanician. It plays the harpsichord, and is fashioned with most delicate art.

When puppets are skillfully constructed, they, in reality, constitute true automatons, and of these the old Seraphim Theater offered some ingenious examples to the eye of the spectators. They are still in existence and are preserved in the collection of Mr. Maury, who has formed a small museum of the puppets of all times and all countries. In this collection, which we visited not long ago, we saw some puppets that figured in the fairy scenes at the Seraphim. Some of these are so constructed that they can be suddenly converted into vases of flowers. The arrangement by which this change is effected is very ingeniously conceived.

Mr. Caran d Ache, one of our most talented draughtsmen, not long ago resuscitated Chinese shadows, and we have already pointed out what has been done in this line by this intelligent artist, who has had successors of no less merit. Now it is one of our most distinguished painters, Mr. George Bertrand, who has set himself to work to manufacture puppets, or rather automatons, which he calls animated models, and which are exhibited every evening at the Alcazar Theater, at Paris. These figures of Mr. Bertrand's seem to be actually alive. Instantaneous photography alone can give a nearly perfect idea of these well gotten up little characters. We cannot figure them all, and shall offer but a few specimens to our readers. In Figs. 1 and 2 we have a scene from La Rencontre, one of the best of the representatives. When the characters make their appearance, and walk, and approach each other, we have an image of reality. It is not puppets that are operating, but actors who are playing a comedy.

FIG. 1.—BERTRAND'S ANIMATED PUPPETS.

The hero of Mr. Bertrand's representation is a little violinocellist with bristling hair, who bows, rubs resin on his bow, and begins the Rakocsey March. The little musician plays with wonderful accuracy. Everything is there—the movement of the arm that guides the bow, and that of the hand that runs over the strings. When the applause comes, the player bows, expands his chest, and plays again. He has an air of pride that his merit has been recognized.

FIG. 2.—LA RENCONTRE (SECOND SCENE).

FIG. 3.—AUTOMATIC DANSEUSE.

Mr. Bertrand's danseuses are none the less wonderful. We have reproduced one of these whose attitude, as may be judged from the engraving (Fig. 3), is thoroughly natural. There are certain gestures of these danseuses that excite applause.

It will be readily conceived that we were not satisfied to see the representation of these animated figures; we are so fond of the curiosities of physics and mechanics that we were unable to resist the desire to know Mr. Bertrand's processes. So we requested him, for our purposes, to take one of his puppets apart, so that we could see what there was inside of it. Mr. Bertrand, with the best of grace, admitted us to the side scenes of his miniature theater. We even surprised one of the *premieres danseuses* at the moment when the disarrangement of her toilet was undergoing repair. An instantaneous photograph of this scene was at once taken for our readers (Fig. 4).

These little puppets are half life size, being about 32 inches in height. They are suspended from the upper part of the theater by very fine wires fixed to a rubber spring. Left to itself, the puppet is suspended about three feet above the floor of the stage. It is from beneath that the operators, holding it by means of wires attached to its feet, keep it on the floor and make it walk, jump, or dance. Lateral wires are attached to the hands and manipulated from the side scenes. These actuate the arms. But the secret of the incomparably truthful aspect of the automatons' motions consists in the care and method with which they are elaborated and constructed. The painter has bestowed much observation upon the attitude of animated beings, and understands human anatomy thoroughly. Now he has succeeded in constructing his wonderful puppets through a remarkable synthesis. Each figure is formed of a very skillfully wrought skeleton, one of which we represent in Fig. 5. Here we observe the fundamental osseous framework made of hard wood, and the articulations formed of steel springs. When this wooden skeleton is made to dance upon the stage, it has absolutely the attitude of an animated being, and all the articulations operate of themselves with perfect suppleness.

FIG. 4.—THE TOILET OF A DANSEUSE.

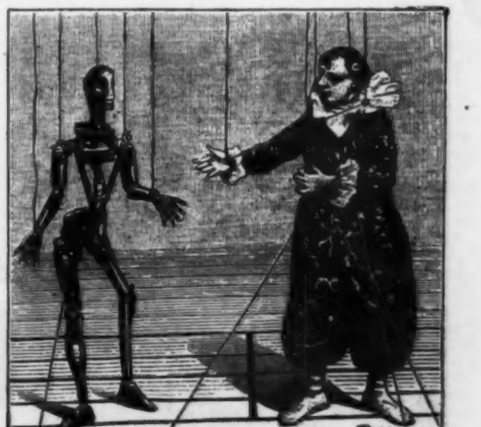


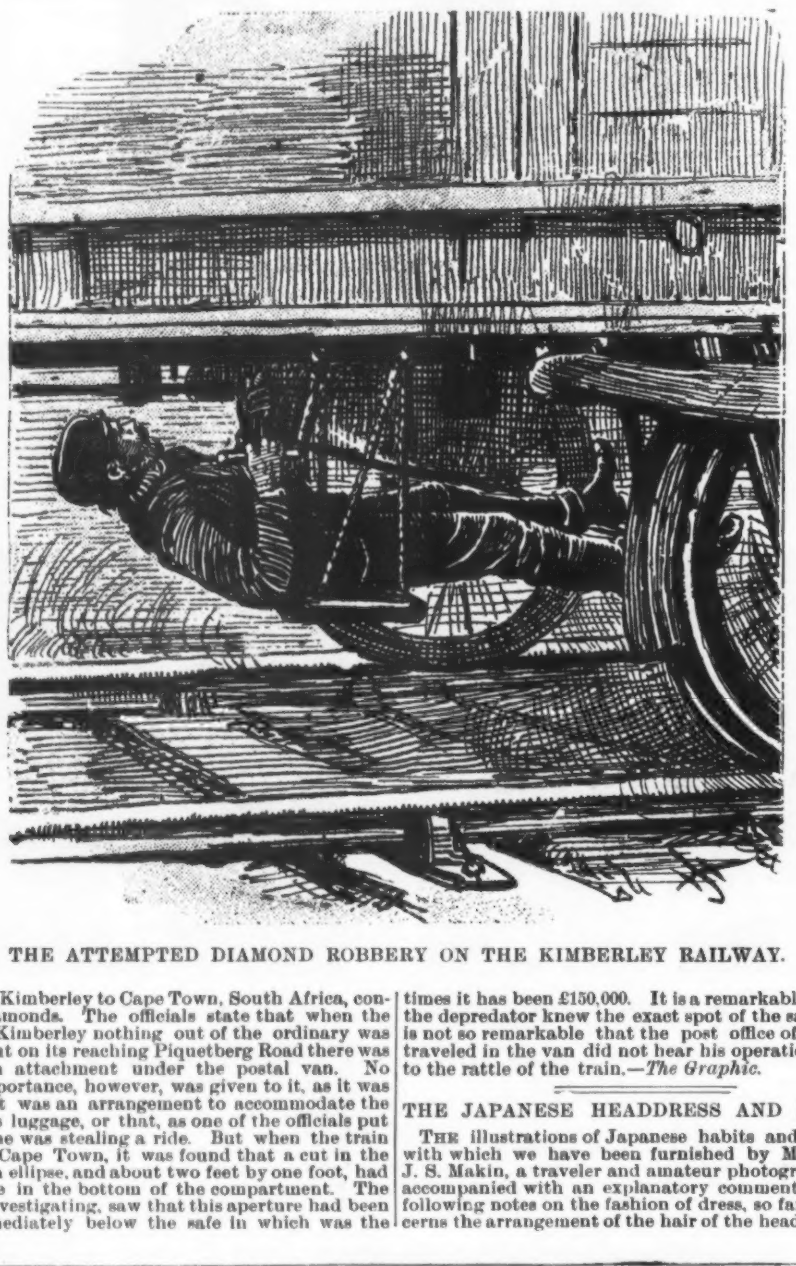
FIG. 5.—TOM MINOR, THE CLOWN, AND HIS SKELETON.

A covering of tow and properly modeled tissues gives the external human form, and one is astonished, when he maneuvers these automatons himself, to see how excellent the motion of each limb is. The feet and the hands are flexible, and the arms and legs operate naturally. This is due to the skillful construction of the skeleton.

Alongside of the wooden skeleton (Fig. 5), we represent the clown, Tom Minor, who, at the rising of the curtain, recites the strophes of the prologue. He is capable of showing his own skeleton to the spectators, and of saying: "This is the way I am made. Look at my framework."—*La Nature.*

ATTEMPT TO ROB A DIAMOND CAR.

ONE of the most daring attempted robberies on record was an endeavor recently made to rob the mail train from Kimberley to Cape Town, South Africa, containing diamonds. The officials state that when the train left Kimberley nothing out of the ordinary was noticed, but on its reaching Piquetberg Road there was noticed an attachment under the postal van. No special importance, however, was given to it, as it was imagined it was an arrangement to accommodate the passenger's luggage, or that, as one of the officials put it, some one was stealing a ride. But when the train arrived at Cape Town, it was found that a cut in the shape of an ellipse, and about two feet by one foot, had been made in the bottom of the compartment. The staff, on investigating, saw that this aperture had been made immediately below the safe in which was the diamond output from Kimberley. They at once came to the conclusion that the diamonds had been stolen. Fortunately, however, the gems were safe, and the daring thief had evidently been surprised by the too speedy return of daylight, or had broken his auger. This safe is about one foot nine by one foot two inches, and always occupies one spot in the van, being fastened to two uprights; it is further secured by clamps. The thief had made a hole in two places, and seventeen cuts in all. Below the carriage he had rigged up a seat which was 2 ft. 3 in. long, consisting of a plank with rope attached to the connections of the brake. The seat swung only 2 ft. 3 in. below the level of the van, and the daring fellow must have sat on this risky bench, and, with feet against some projection, have pierced flooring and safe. The latter was about three quarters of an inch from the floor, and contained some £22,000 worth of diamonds—a comparatively small amount, as sometimes it has been £150,000. It is a remarkable fact that the depredator knew the exact spot of the safe; but it is not so remarkable that the post office officials who traveled in the van did not hear his operations, owing to the rattle of the train.—*The Graphic.*



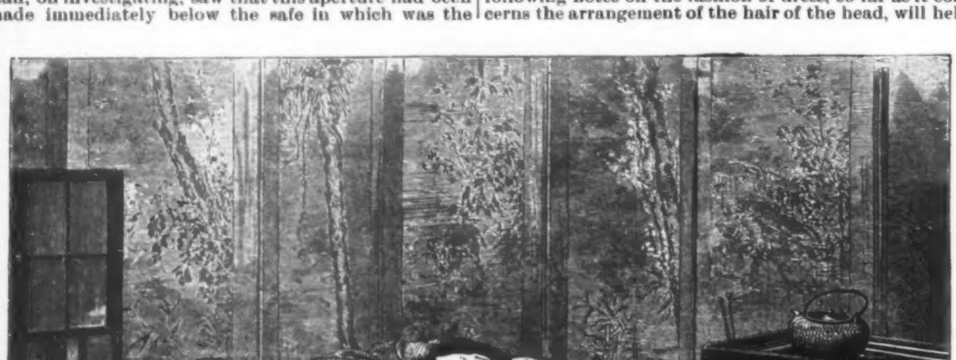
THE ATTEMPTED DIAMOND ROBBERY ON THE KIMBERLEY RAILWAY.

THE JAPANESE HEADDRESS AND PILLOW.

THE illustrations of Japanese habits and manners, with which we have been furnished by Mr. Charles J. S. Makin, a traveler and amateur photographer, are accompanied with an explanatory comment; and the following notes on the fashion of dress, so far as it concerns the arrangement of the hair of the head, will help to show the reason for what seems an uncomfortable way of going to bed at night: "The Japanese dress is easily described. A series of loose wrappings, with a gown, Kimono, over all, is common to both sexes. The distinguishing feature between them lies in the 'obi,' or girdle worn by the women. It is wrapped round the waist, and tied into a bow at the back. Though usually worn of one subdued color, the holiday 'obi' is a very elaborate affair. The rich embroidery which adorns it is of the very best material that the purses of the wearers will afford. It is really the only part of their costume which gives them scope for display, with the exception, perhaps, of their headdress.

"The headdress is a most elaborate affair, built on a foundation of cardboard, which is blackened; the hair, being passed over it, is then smoothed down and well oiled, and into it they put flowers, combs, fancy pins, and other small articles, intended to heighten their personal attractions. The result is frequently an artistic triumph. It is a tedious process, and perhaps for this reason habit has taught them to sleep without soft pillows; instead of which they use a round piece of wood, like a rolling pin, about eight inches long, supported on two wooden feet, and with a hollow for the neck to lie in; so by these means the ladies are able to leave their hair untouched for several days, as at night it does not become at all disarranged; and for that consideration, of course, they can reconcile themselves to its use.

"The male attire is similar, in many respects, to that of the other sex; but the 'obi' worn by men is only a narrow band wrapped several times round the waist, and with no embroidery or bright colors to make it conspicuous. In this girdle the man will carry pen and ink in a case, also his tobacco pouch and pipe; and very frequently the much caricatured fan. The national costume is certainly pleasing in its simplicity, but now European dress is rapidly being adopted, which is a pity, as it tends a great deal to destroy the characteristic look of the people."—*Ill. London News.*



A JAPANESE PILLOW.

OHM'S LAW AND ITS PRACTICAL APPLICATION TO ELECTRO-THERAPEUTICS.

By HENRY N. WINTON, M.D., San Francisco, Cal., Assistant to the Chair of Materia Medica and Medical Chemistry, University of California, Medical Department.

As electro-therapeutics, or the science of electricity applied to the treatment of disease, is concerned with all of the varieties of electric currents that may be produced, and as each current has its own distinct physical properties, as well as therapeutical actions, it naturally follows that a knowledge of electro-physics—the scientific basis of electro-therapeutics—is essential in order that the operator may use electricity effectively and extend his knowledge beyond mere empirical practice. Much of the unfriendly criticism of some members of the profession, and the ill success of many who are now making common use of electricity as a therapeutic agent, is, in the light of accumulating clinical facts and the experiences of scientific workers in this department of medicine, dependent upon insufficient knowledge of the laws which govern and of the varying qualities and nature of electric currents. A knowledge of what the physician is prescribing is no less important in electricity than in the use of any other therapeutic agent.

There is, probably, no one subject in electro-physics of such practical value to the physician and at the same time so generally neglected as the law of electrical currents discovered by Ohm. Ohm's law has, not without reason, been called the "north star of dynamical electricity," for it comes into play in all practical applications of electricity, explains many facts relating to the uses for which certain forms of batteries are best suited, and forms the basis of all electrical measurement. The operator who bears its essential points in mind will have a more just conception of the problems he encounters in his work, a clearer understanding of many clinical facts indirectly related to the subject, and of the *rationale* of the methods of application used by electro-therapeutists.

Ohm's Law.—The *quantity* of electricity passing through any point in a circuit varies *directly* as the *electro-motive force*, and *inversely* as the *resistance.*

In order to make this law and its application clear, it is important, first, to define the terms already introduced, and some of the units of electrical measurement.

Potential.—All substances have an electrical condition known as potential. A substance from which electricity tends to flow toward the earth is called positive or of high potential, while a substance which tends to draw electricity from the earth is called negative or of low potential. The element most acted upon in a galvanic cell has the highest potential.

Quantity and Intensity of the Current are terms used to denote the strength of the current, or the amount of electricity passing through the circuit in any given time.

Electro-motive Force is a term used to denote the sum of all the differences of potential in a galvanic circuit. It is "the force that urges forward the current."

Resistance is a term used to denote the degree of obstruction opposed by the circuit to the passage of electricity through it.

Internal Resistance is the obstruction offered to the passage of the current between the elements of a cell.

External Resistance is the resistance outside of the battery.

An Ohm, the unit of resistance, is the resistance necessary to produce one ampere of current under an electro-motive force of one volt.

The Volt is the unit of electro-motive force, *i. e.*, "the unit of measurement of the pressure at which a current is delivered." A volt is the amount of electro-motive force necessary to yield a current of one ampere through an ohm of resistance. For medical purposes the current is measured in *milliamperes* or thousandths of the *ampere.*

Now that we are prepared to consider the law of Ohm, we certainly cannot find a better example, illustrating at the same time its importance and practical value, than in the misapprehension so common among physicians regarding the effect of the size of cells upon the quantity of electricity passing in the circuit. The

difference of potential being the same, the electromotive force of a cell of given elements is the same whether the size be large or small. The internal resistance of the former is less, because the "resistance of the column of fluid between the elements varies inversely as its sectional area." Now, if the external resistance be low, the large cell will give the greater quantity, but if the external resistance be high, the advantage gained by the diminution of the internal resistance will not materially increase the intensity of the current. This is shown by Ohm's law, which, for convenience, we will express in the following equation:

$$\text{Quantity} = \frac{\text{electro-motive force}}{\text{internal resistance} + \text{external resistance}}$$

$$\text{or } Q = \frac{E}{IR + ER}$$

In a battery of fifty small cells let the electro-motive force of each cell be 1 volt and the internal resistance 2 ohms. Let the external resistance be 15 ohms. We have

$$Q = \frac{50 \times 1}{(50 \times 2) + 15} = .435 \text{ or } 435 \text{ milliamperes.}$$

In a battery with plates five times as large the internal resistance is one-fifth as much (0·4 ohm), while the external resistance (15 ohms) and the electro-motive force (1 volt) remain the same. We have

$$Q = \frac{50 \times 1}{(50 \times .4) + 15} = 1{\cdot}428 \text{ or } 1{,}428 \text{ milliamperes.}$$

Thus there is a great gain in the use of large cells if the external resistance is low, a fact, as we shall see presently, utilized in the construction of cautery batteries. When the current encounters great resistances, like those of the human body, a large cell gives approximately the same quantity as a small cell. Here, again, Ohm's law comes to our assistance. Let us suppose that the external resistance is 1,000 ohms. With the fifty small cells,

$$Q = \frac{50 \times 1}{(50 \times 2) + 1{,}000} = .045 \text{ or } 45 \text{ milliamperes.}$$

With the fifty large cells,

$$Q = \frac{50 \times 1}{(50 \times .4) + 1{,}000} = .049 \text{ or } 49 \text{ milliamperes,}$$

a quantity that is, it is true, a little larger, but not enough to be worth considering. While the large cells give us practically no increase in current strength, hence no therapeutic advantage, experience teaches us that medium sized cells should be selected for batteries designed for medical purposes (galvanization, electrolysis, and chemical galvano-cauterization), on account of the greater amount of materials they contain. They last longer, do not require attention so often, and furnish a current of uniform volume.

If there were no external resistance, one cell would give as much current as a hundred, or, indeed, any number of cells. With a cell having an electro-motive force of 2 volts and an internal resistance of 0·3 ohm, we have, according to Ohm's law,

$$Q = \frac{2}{.3 + 0} = 6.66+ \text{ amperes.}$$

With a hundred similar cells we have

$$Q = \frac{2 \times 100}{(100 \times .3) + 0} = 6.66+ \text{ amperes.}$$

It will be readily seen that, in devising a battery for cautery purposes, where the external resistance is very low, large cells should be used, and, as little gain will be effected by multiplying the number of cells, a very small number is required.

One of the most important lessons learned from Ohm's law is the necessity of a more scientific and accurate basis for recording observations and directing treatment than by stating the number of the cells used. The electro-motive force varies in different batteries, and in the same battery from day to day, owing to the gradual exhaustion of the battery fluid, from polarization, and other causes. The internal resistance is also a variable element for similar reasons. But it is in the external resistance—the resistance afforded by different individuals—that we find the greatest variance and inconstancy. Not only does the conductibility of the same tissues vary in different individuals, but the thickness and moisture of the skin, the material and moisture of the electrodes and the degree of pressure with which they are applied to the surface of the body, and the duration of the sitting, all determine differences in the resistance, hence we can readily understand that there can be no constant relation between the number of cells in the circuit and the intensity of the current. Precision of dose being no less important in electricity than in the use of any potent remedy, the introduction of the milliampere meter marks an important advance in medical electricity, as the deflections of its needle measure the intensity of the current that passes through the body and represent the dose actually taken. This is an element of the utmost importance to every operator who uses the galvanic current and expects to repeat the treatment followed by others or intelligently report and record his own observations. The milliampere meter forms an indispensable part of an electrical outfit.

Directly and indirectly we owe to Ohm's law the explanation of many important clinical facts which have long been practically recognized.

1. Toward the end of a *stabile* galvanic application a current of definite electro-motive force is more perceptible to the patient, and the milliampere meter registers an increase in the current strength, owing to the diminished resistance of the skin as it becomes thoroughly moistened.

2. Electrodes applied to the surface of the body firmly and evenly render the current more uniform and even, and assist in its conduction by diminishing the resistance.

3. Saturating the electrodes with a weak solution of *sodium chloride* increases the conductivity of the skin by lessening the resistance. For the same reason electrodes wet with warm water conduct better than those wet with cold water.

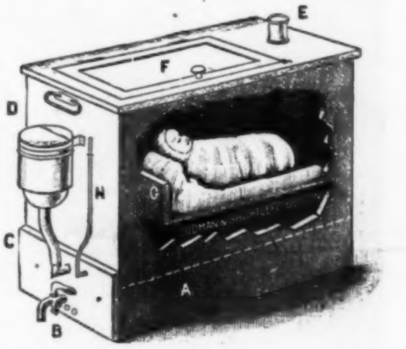
4. "The density (compactness of the current) is in inverse proportion to the size of the conductor through which it flows; therefore, with the same current strength, it is greater when we apply small, less when we apply large electrodes. When the area of disease is near the surface, we often apply small electrodes in order that as dense a current as possible should enter it;" but if we wish to affect a deep structure by percutaneous transmission, without excessive pain, large electrodes should be used, for the reason that, as the current becomes very much diffused before reaching it, it is necessary that a large quantity of electricity should enter the body.—*Pacific Med. Jour.*

LA COUVEUSE, FOR PRESERVING THE LIFE OF FEEBLE AND PREMATURELY BORN INFANTS.

APPARATUSES for this purpose have been successfully used in Europe for a number of years, and the accompanying illustration represents one, modeled after the most perfect form, as exhibited at the Paris exhibition in 1889.

It consists of a wooden case, 28 inches long, 23 inches high and 17 inches wide, having a glass door, F, and ventilating valve, E, on the top, a tunnel, D, with cover, gauge glass, H, faucet, B, and ventilating openings, *f*, on the front, and a larger ventilator on the back (not shown). Within and at the bottom is a copper reservoir of suitable capacity (shown in dotted outline, A) connected with the tunnel, also with the faucet, B. Over the reservoir is a frame with a thermostat attached for regulating the internal temperature. Above is the bed for the child, with the mattress, etc. A sponge cup and sponge for moistening the air, and a thermometer are conveniently placed.

When the apparatus is to be used, the reservoir should first be filled with boiling water three or four hours in advance to warm it thoroughly; when the internal temperature reaches 85° to 88° F., the infant may be placed within on the bed. To maintain the temperature it is generally sufficient to add three quarts of boiling water every two or three hours, at



the same time drawing off an equal quantity from the reservoir by means of the faucet, the gauge glass, H, showing when the reservoir is filled.

The warm air rising from the reservoir escapes through the valve, E, in which turns a little helix; should the temperature within rise too high, the thermostat opens the ventilator at the back and admits the outer air until it is reduced, when it closes again. It is considered well to maintain the temperature at 86° F.

Care should be taken not to place the apparatus in a draft. The infant may be left in the couveuse fifteen days, three weeks, or even a month; then, when it has acquired sufficient vigor, it may be gradually accustomed to the outside air, first removing it into a warm room for an hour or two at a time. It is well, even then, to continue the use of the apparatus during the night for some time longer.—*Med. Record.*

SOME IMPROVEMENTS IN PHARMACY.*

By A. BALL.

IT is very curious to consider the progress made in pharmaceutical science during the last forty years. Prior to this date little progress had been made for two centuries; the pharmacopœia of 1864 was practically similar to the last London pharmacopœia. The reason is apparent; in compiling that edition, the Medical Council did not solicit the assistance of pharmacists in the work, which was to be the criterion of matters pharmaceutical. We may, therefore, safely assert that pharmaceutical advance has not in any way been associated with the pharmacopia or its compilers, but with those disinterested pharmacists who first headed the emancipation movement of pharmacy. Jacob Bell has been called the "Bayard of Pharmacy," and certainly he was a man to be proud of. Circumstances forced him into a position he did not covet, and being endowed with qualifications of the first order, he first stood in the arena as the champion of pharmaceutical progress, and possessing the best attributes of scientific knowledge, he, like a magnet, attracted to his side many other prominent pharmacists of that day. Among other eminent men we may mention Allen, Payne, Savory, and Morson. These pioneers of pharmacy worked with ardor to perfect the then indifferent processes assigned for the manufacture of pharmacopœial preparations. These gentlemen were ably assisted by Pereira, Fownes, and Redwood. The text book of Pereira is even now looked upon as a result of careful thought and investigation. Hanbury, in his pharmacographia, gave the complete and practical information respecting the origin and mode of preparing the articles comprising the materia medica of his day.

It is strange, however, to observe the apathy of the pharmaceutical masses. Much remained and still remains to be done to perfect pharmaceutical science. Pharmacy, however, does not remain alone in this respect. When Stephenson invented the locomotive engine, the major part of his fraternity considered this gigantic stride in engineering science to be a forlorn hope, impracticable, and of interest only as an experiment; yet we all now appreciate the benefits conferred upon humanity by Stephenson's triumphal experiment. When gaslight was suggested as an advance upon existing means for street lighting, the originator was ridiculed, not only by the intelligent public, but by men of science; among others the famous chemist, Sir Humphry Davy, considered the idea impracticable, and fraught with the certain danger of explosion. Still we now fully comprehend the advantages of this scientific conception. The discovery of new antiseptics has completely revolutionized the treatment of wounds. Cocaine, a comparatively recent discovery, isolated by Niemann in 1860, is now considered to be of the utmost value as a local anæsthetic when applied to mucous membranes. This alkaloid, however, does not represent the complete therapeutical value of coca; neither does the fluid extract of the pharmacopœia. We are all aware that the natives of Bolivia chew the leaves in conjunction with lime or ashes to stimulate exertion or appease hunger and thirst when traveling long distances. This stimulating action is in the most part due to hygrine, a volatile hydrocarbon contained in the leaves, but generally volatilized in manufacturing the fluid extract by the pharmacopœia process.

This is not a solitary instance of imperfect pharmacy. In the fluid extracts of bael, cascara sagrada, cimicifuga, cinchona, coca, ergot, rhamnus frangula, sarsaparilla, taraxacum, one fluid drachm of the extracts is supposed to contain the entire active principles of one drachm by weight of the drug. That this is doubtful when the B. P. processes are carried out is easily understood. For example, let us take the fluid extract of coca. The pharmacopœia directs that 40 of the menstruum should be poured upon 20 of the drug in No. 40 powder, packed in a percolator, let it stand for 48 hours and then drain it; reserve the first 15 of the percolate and evaporate the remainder by a water bath to the consistency of a soft extract; dissolve this in the reserved portion, and add sufficient proof spirit to make 20 fluid ounces. I would respectfully suggest that it would be better to direct sufficient spirit to be poured upon the drug to cover it, and that a layer of the menstruum should not be maintained constantly above the drug. The quantity first employed should be allowed to stand 48 hours, and then the solution run out of the percolator, as far as possible, before more of the menstruum is added, care being taken that the top layer does not become dry. As the mass is apt to be loose after the removal of the extractive matter, it should be pressed down gently after the first liquid is drawn off. Each time the menstruum is added it should completely fill the packing from top to bottom. The second lot should stand 24 hours and then drain off. No further liquid to be added until the flow of liquid from the percolator becomes very slow.

By this process more extractive is obtained with less menstruum. I have found this procedure answer much better than an excessive amount of spirit added directly after the first percolate has drained off. The supernatant layer of menstruum is useless and only facilitates loss by evaporation, for it is observed that it keeps perfectly clear, and gradually diminishes in quantity. Then the evaporation on a water bath is so much loss of spirit. Why not distill it off, at a low temperature, and employ it next time for the same process? A fluid extract half the strength would be a more active preparation comparatively. When we are dealing with delicate hydrocarbons, heat is generally extremely dangerous to their stability. Several other fluid extracts, not official, are very readily spoiled by the process of evaporation. Take for instance the fluid extract of wild cherry, which is rather extensively employed in cough mixtures. The process of the American pharmacopœia insures the complete volatilization of hydrocyanic acid, which possesses the chief physiological action of the drug. Then we have also the vinum ipecacuanha of the B. P., evaporating the fluid acetous extract to dryness over a water bath before macerating it in the sherry. This process again appears defective, for we know that the alkaloid emetine is easily decomposed by heat, so that with a maximum amount of trouble we obtain a minimum amount of active principle.

So much for defects. Now we will turn to the improved method of preparing fluid extracts, viz., that of cold repercolations as originated by Dr. Squibb, the well-known pharmacist. This implies the successive application of the same percolating menstruum to the portions of the substance to be percolated. The object in view is the saving of spirit and neglect of evaporation. Then we have the system of percolation and maceration with hydraulic pressure, which can only be performed in large laboratories; also the process of maceration and percolation in vacuo. Of these the system of cold repercolation is really the best, and the difference in appearance of the extracts when prepared by this system and those by the B. P. process is remarkable. We may revert to our friend, the coca fluid extract. When prepared by the former process we obtain a beautiful clear green product, rich in active principles; and by the latter a brownish green, thick product, which has suffered more or less decomposition. Now we will refer to the tinctures. These frequently vary in the amount of extractive matter yielded when evaporated on a water bath. This, of course, may be to a certain extent due to the different conditions of the drugs employed. Still the difference in some instances is remarkable, and can only be accounted for by defective manipulation. It would be advantageous for the pharmacopœia committee to decide as to the minimum amount of extractive to be contained in all tinctures. The tinctures of myrrh and ginger would be much better prepared if the powdered drugs were directed to be first mixed with glass, broken in small pieces. Agitation is generally effected with difficulty, unless previously so treated. This, however, is only by the way, and may suggest some improvements in the pharmacopœia processes.

I have observed a distinct advance in pill manufacture; these are now generally beautifully made by machinery and coated with sugar, French chalk, or gelatine. They are frequently elegant in appearance, but become very hard by age, and therefore it is a very serious question to be considered as to whether, when

* Read at the Westminster College of Pharmacy. Reprinted from British and Colonial Druggist.

a certain therapeutic effect is desired, it would not be advantageous to revert to the old plan of preparing them fresh, for prescriptions. Physicians are, nowadays, much more attentive to the physiological action of the drug required, and when it is desired that the pill should be absorbed from the intestines, it is directed to be coated with keratin. Pills of pancreatin, sodium taurocholate and calcium sulphide are usually dispensed in this way.

Many physicians now prescribe the compressed tabloids of drugs, which are generally found more certain to produce the physiological effect of the substance employed. The synthetical compounds, extensively employed in medicine, are a new departure in therapeutics. Cocaine may be prepared synthetically by heating ecgonine (methyltetra-hydro-pyridyl-oxypropionic acid) with benzoic anhydride and methyl iodide. Quinine is now considered to be a derivation of a partially hydrogenated diquinoline. The abundant natural sources from which these alkaloids are readily obtained does not, however, necessitate the aid of synthesis.

Perhaps, however, a recital of some of those recently introduced compounds which have become so popular with physicians may be of interest.

First, we will refer to the group of methane (CH_4) derivatives, which are chiefly hypnotics and anæsthetics, amylene hydrate (tertiary amyl alcohol), paraldehyde, urethane, sulphonal, are the most important among others.

The second group comprises the phenols and allied compounds, phenyl salicylate, known as salol, sozoiodol and betol; these are the chief therapeutic agents of this group.

It is remarkable that, with the advanced knowledge of synthetical chemistry, there cannot be found, commercially, a pure phenol or artificial salicylic acid, both the so-called pure acids contain an appreciable amount of cresyl (cresylic acid), which interferes considerably with their proper physiological action.

Each compound in this group is antiseptic and antifermentative.

The third group comprises phenyl derivatives, the chief articles employed in medicine being antifebrin, saccharin, phenacetin, and pyrodin.

The fourth group, pyrazol (C_3HN_2O), includes many well known antipyretics and analgesics. These are very extensively employed in medicine, and it is a matter of much regret that English chemists do not pay more attention to synthetical architecture, and manufacture those articles now supplied by the Germans.

Another article of recent manufacture has done much to revolutionize the manufacture of ointments. This substance, known to the ancients as orsypus, and extensively employed as a cosmetic by both Greek and Roman ladies, was purified and produced in a suitable condition for employment in modern pharmacy by Prof. Liebreich, of Berlin. This comparatively new ointment basis, known throughout the world as lanoline, has been found by dermatologists to possess powers of penetration into the epidermis peculiarly its own. Lanoline is a compound cholesterin fat and said to be natural to the cutaneous tissues, thus differing entirely from the glycerine of mineral oils and fats hitherto employed.

The constituents of lanoline, as now supplied, are as follows:

Stearic acid, cholesterin alcohols, capric and caproic acids (the volatile fatty acids), ceryl cerotate, cholesteryl cerotate, a trace of mineral matter, and 20 per cent. water.

The acids do not exist in a free state, but are combined with the cholesterin, similar to the cholesterin ethers of the stearic and some of the oleic acid series. We can therefore understand why this new basis does not turn rancid; also why it retards the natural inclination of the glycerine oils and fats to become rancid.

Some pharmacists complain of its adhesive properties. This difficulty may be overcome by mixing the lanoline with a suitable proportion of glycerine fat or oils. When added in small quantity to cold cream, it assists in retaining the water and prevents decomposition, at the same time adding to its cooling and healing properties.

In the discussion Mr. Will said we were indebted to Merck for the first synthesis of cocaine, but few people understood what the base (ecgonine) really was, and he was glad to know its complete chemical composition.

The chief questions asked were referable to lanoline. The experience of one gentleman present was decidedly unfavorable for the cholesterin ointment base. He had tried to mix it with glycerine, but without any satisfactory results. It was pointed out that glycerine and lanoline were incompatibles, and it was generally found out that mixed incompatibles never produced a satisfactory compound.

Another gentleman had experienced difficulty in making a satisfactory ointment of ichthyol with lanoline. It was shown that ichthyol was only perfectly miscible with lanoline to the extent of 25 per cent. The questioner had tried a higher percentage. It had been found in one instance that the admixture of the following ingredients produced a reduction of the calomel: ℞. Calomel, cocaine hydrochlorate, lard, and lanoline. The cause was suggested to be the action of free fatty acids upon the calomel, similar to the case of the ung. hyd. oxyd. rub. The red oxide was frequently found, after a time, to be reduced to black oxide. According to Roscoe's ruling, no substance could be a perfect fat unless it contained glycerine. Mr. Ball said lanoline was held to be fat in the same sense as petroleum fats, which did not contain glycerine.

PROTECTIVE MIMICRY IN A FISH.

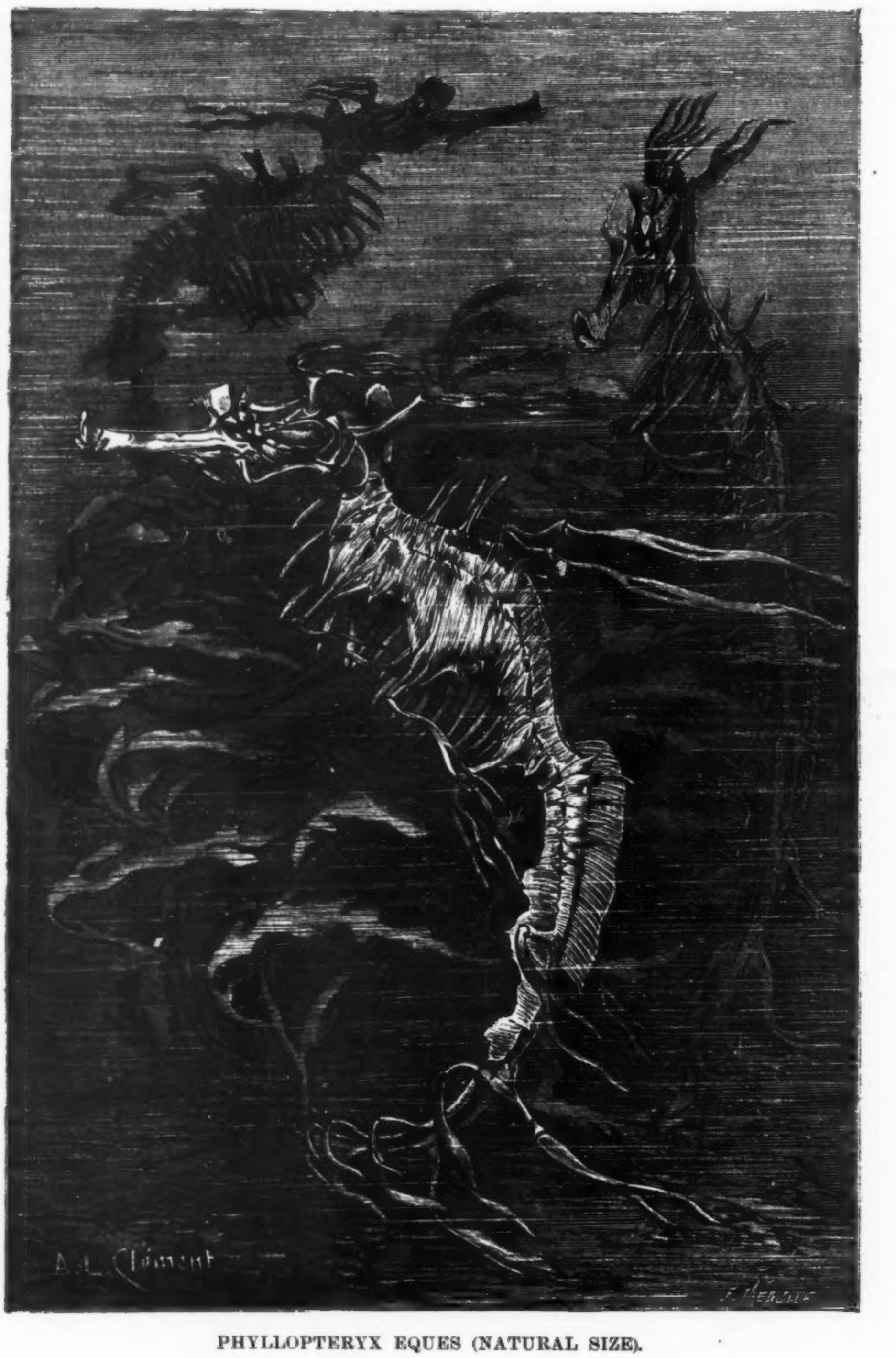
BY the term "protective mimicry" we designate the property that certain animals possess of reproducing the form and color of other species endowed with some advantageous peculiarity which guarantees them against the attack of their enemies. By favor of such resemblance, the imitating animal is likewise protected by this peculiarity, which it does not itself possess. It is chiefly among insects that the samples of this kind are met with. In other cases, and these are the most frequent ones, mimicry consists simply in the similarity of aspect, of color, and sometimes of form, observed between an animal and the surroundings or the inanimate objects amid which it lives. It is through mimicry that the hare, the partridge, and the quail affect the color of the earth, and that the northern hare, which inhabits cold and snowy regions, has a cinnamon-brown coat in summer and a white one in winter. So it is through mimicry that certain fish which are very poor swimmers, such as the turbot, sole, etc., cannot be distinguished from the sandy bottom upon which they rest immovable, and that numerous tree-inhabiting serpents have taken on the green color of the foliage in which they are constantly on the watch.

The advantages that animals derive from their mimicry are of the highest importance to them. Those that are feeble and defenseless owe to it the faculty of escaping the sight of their enemies, which are as numerous as merciless; and those, on the contrary, that nature has powerfully armed, and that feed upon living prey only, which they are incapable of pursuing, can, while immovable, await their victim with the certainty of not exciting its suspicion, and seize it at the very moment that it thinks itself safest. In both cases, it is the very preservation of existence that is in play.

One of the most curious examples of mimicry among fishes is offered us by the *Phyllopteryx eques*, of the order Lophobranchiates, or tuft-gilled fishes. Everything is strange in this animal, and nothing in its form, its cutaneous covering, or its habits recalls what we observe among ordinary fishes.

The head, terminating in an elongated tubular snout, at the end of which opens a small toothless mouth, forms an angle with the anterior part and narrows from the trunk that carries it, and thus offers a certain resemblance to the head, neck, and shoulders of a horse. A pair of small wattles is observed at the extremity of the snout, and a pair of long appendages in the middle of its lower side. A very prominent crest, followed by a short spine, runs along the median line of the head, on a level with and in front of the eyes, which are large, round, and situated laterally. Upon the occiput, too, there are spiniform protuberances terminating in a tuft of narrow bands, and upon the nape there is a long spine dilated at the base into a median crest, and carrying at its extremity a long bifid thong. The trunk, compressed and attenuated at its two extremities, is deeply indented at the anterior part of the back, and exhibits two deep depressions on the ventral side. The belly and back are provided with long spines that are arranged in pairs on the latter, and in a single median series on the former. These spines have no prolongations; but in the middle of the back and at the summit of each of the three prominences of the abdomen rise a pair of strong spines, provided at their extremity with long, thong-like appendages. The tail, the length of which is nearly equal to that of the trunk and head together, is quadrangular, and its upper edges are provided with five pairs of spines that terminate in long cutaneous bands. By one of those singularities that we should scarcely expect to meet with in fishes, the tail is prehensile at its extremity.

The pectoral fins are situated back of the head, at the anterior extremity of the contracted part of the trunk, and the dorsal fin is situated wholly upon the tail, of which it occupies the anterior third. All the other fins are wanting.



PHYLLOPTERYX EQUES (NATURAL SIZE).

All these details of conformation are clearly shown in the engraving. Let us add that the animal's body, like that of all the Lophobranchiates, is absolutely deprived of scales properly so called, and is covered with juxtaposed plates forming a sort of cuirass.

The *Phyllopteryx* inhabits the coasts of Southern Australia, and lives amid algæ, to which it affixes itself by the prehensile extremity of its tail, and of which it has assumed the coloration. The long, floating thongs with which its body is provided have, through their form, an evident resemblance to the foliaceous prolongations that these plants put forth, and its motions are those that the undulations of the water communicate to the stipe that supports it. Under such circumstances, with its odd form, it passes entirely unnoticed. The small animals that serve it as food come without any suspicion to disport themselves within its reach, and are snapped up in passing. At the same time, its enemies, if it has any (for it constitutes so meager a repast that it must be but little sought for, even by the most voracious fishes), may roam around it without disturbing its quietude. Nothing aside from the odorous emanations that it might emit would betray its presence. So its subsistence is assured without its having to seek it, and, deprived of all means of de-

fense, it escapes its enemies, without even being obliged to flee from them.

This example shows perhaps better than any other under what exceptionally favorable conditions mimicry places the species of animals in which we observe it. As mimicry consists in an ensemble of advantageous characters of a particular order, acquired after a long series of variations, it would remain for us, in order to complete the history of this fish, from the standpoint of protective mimicry, to seek for the reason of these variations; but such a research would lead us very far beyond the limits at our command, and we shall have to waive it.—*La Nature.*

CANE CULTURE AND SUGAR MANUFACTURE IN CUBA.

IN the relentless rivalry which, under the universal law of the survival of the fittest, has converted the sugar industry throughout the world into a struggle for existence or self-preservation, the comparative cost of production, whether from the root or the stalk—whether in the tropics or the temperate zone—has become a subject of vital interest to all engaged in or dependent upon the manufacture of this prime necessity of modern life, which has gradually risen to the rank of one of the great staples, and a matter of considerable concern even to the public at large as consumer. Unfortunately the diversity of conditions which controls it is so vast, not only in the different countries competing for the supremacy, but in different factories of the same locality as well, that to fix any exact standard of specific limit to the expense attending the complex details of all operations in the cultivation of the raw material and its manipulation is practically an impossibility, and an adequate conception of the absolute cost of making a ton of sugar in any part of the world can only be reached by taking two extreme cases or types, and striking a general average between them. This is what will be attempted here with regard to the island of Cuba, indicating approximately, not only the highest economy actually attained, but also the minimum clearly possible when all the best known means at command are employed.

The first factory I shall cite is probably not the only one of its kind in this country, for there are large tracts of land as good and similarly situated, where the same economic results are possible, but it is the only one of which I have positive data, and for this reason it has been selected. Its lands lie along the southern coast, where the climate from greater heat and moisture is perhaps even more favorable to cane culture than the more extensively developed opposite side of the island. The rich soil reaches to the very edge of the Caribbean Sea, where there is sufficient depth of water to admit steamers to the factory's own wharf. The soil is apparently of volcanic origin, and probably resembles the richest lands of the Sandwich Islands. It is porous enough to require little or no drainage, and yet retentive enough for all purposes. The yield of cane to the acre is so large that, if stated, it would in all likelihood be thought an exaggeration; nevertheless the ratio of sucrose is very high—advantages so seldom combined that practical planters will readily appreciate their influence upon the results. As regards cultivation in the scientific sense of the term, there is none. The plow is still an unknown factor upon this estate, nor could it be used without removing the stumps—a practice never thought of in Cuba. All agricultural operations are limited to the primitive practices of putting the seed into the holes, and afterward keeping the adventitious plants in subjection with the hoe, to prevent them from exterminating the crop. But one mill is used, and although an excellent one of its class, cannot, grinding so large an amount of cane as it is forced to, attain a very high extraction. The apparatus is good, but it is far from uniting all the best requirements known to sugar house engineering. The estate raises no cane directly, and all the lands are divided out among *colonos*, or colonists, as they are termed here. Tenant farmers are paid for it at the rate of $2 per hundred *arrobas* of twenty-five pounds each, which constitutes the Cuban cartload or ton. This price includes everything, cultivation, cutting, loading, and carting, delivering it *upon* the cane carrier, as all cane in this country is unloaded, and not upon the ground at the mill house. The works are but a few furlongs from the water's edge, so that the sugar is taken directly from the sugar house to the side of the vessel by rail and reaches the United States without breaking bulk. The total cost of producing sugar at this factory, including the price of the raw material, *is less than one cent per pound on board.*

The price paid for cane in this case is so remarkably low that it will lead to the supposition that the reduced cost of production is attained at the expense of the tenant farmers, and we will therefore inquire what are the expenses they incur in its cultivation. These fields having been planted in virgin soil immediately after felling the forest, if the few weeds which appear are not allowed to go to seed, give very little trouble in cleaning them after the primitive fashion adopted, and the cane moreover grows so rapidly that it scarcely gives time for more than one hoeing before the foliage completely shades the ground, checking all other vegetation. We will nevertheless count upon the usual number of three weedings, at the prices paid for this work in good fields throughout the most populous sugar belt of the island, which per *caballeria* (of 33⅓ acres) will be about the following:

First hoeing	$50
Second hoeing	40
Third hoeing	30
Total	$120

or approximately $3.60 per acre. If the expense is greater than this, it is due to carelessness on the part of the tenants. The yield in cane, as has been stated, is enormous for the first year, and subsequently it is proportionately large, but putting it at an average of only 700 cart loads of 2,500 pounds to the *caballeria* (33⅓ acres), the expense of reaping and delivering the crop will be—for cutting and loading in such fields about 50 cents, and for cartage nearly the same, which added to the cost of cultivation would be about $820 per *caballeria*. Deducting this amount from the $1,400 received for the cane would leave an average balance in favor of the tenant of $580 per year, or, at a rough estimate, $17.50 per acre. As the cost is calculated at contractor's prices, if the farm is larger than the tenant can cultivate unaided, he makes, over and above the sum stated, a contractor's profit on all the work; or if he does the cultivation with his sons, as is often the case, he not only has his gain, but makes average daily wages for all employed besides. It is evident, then, that in the specially favorable conditions of this estate the tenants are not sacrificed to the cheapness of production, but make money from their farms, and far more than this class of people in Cuba can by any other means. This condition of things may continue for a long time, for it requires thirty or forty years of this improvident system to exhaust such lands; and if the Louisiana practice of employing the cow pea were adopted, supplementing its deficiency in phosphoric acid by the use of the cheaper kinds of phosphates, the fertility of the soil might be preserved indefinitely, with a very slight enhancement of the cost of the cane, or perhaps with none whatever, as the expense would be more than compensated by the increased yield of the fields. What has been related so far shows what is actually being done under extremely favorable circumstances in the island of Cuba. Let us inquire what *might* be accomplished if these great natural advantages were duly improved by a higher order of management and more perfect machinery and manufacture.

We find in the first place that by cultivating the fields with the plow instead of using the hoe, or better still with the special implements used in Louisiana, the yield of cane and sugar would be greater at less expense; and, furthermore, that if the proprietor worked and reaped his fields by contract instead of depending upon tenants, between these two gains he would reduce the cost of his raw material to about one-half the sum he is now paying for it, cheap as it is. By using two mills and regrinding his cane with maceration, which by utilizing the best appliances for economizing fuel can be done without any extra expense, the extraction would be increased about 12 per cent., and even more if the hydraulic regulator were applied to the mills. With a thoroughly perfected apparatus and the sugar house under adequate chemical control, 10 per cent. of first sugars should be obtained from such rich canes, which would amount to a yield of 250 pounds from a load of cane costing only about $1. To those who may believe this to be exaggeration I can cite the case of a plantation with a very old and weak mill and common open kettles, which from poorer cane has attained year after year a yield of 7¾ per cent., and another with an imperfect modern plant which obtains 9¼ per cent.

A good green bagasse burner would save the wages of all the hands employed in carting, drying, and stoking the bagasse, which, on an estate of the size of the one referred to, would amount to a saving of about $50 per day, besides avoiding the losses entailed by stoppages caused by showers, which wet the fuel without otherwise being sufficient to prevent work. With a properly constructed strike or granulating pan and pumps large enough to maintain twenty-eight inches vacuum, the sugar can be cooled enough before striking to go directly into the mixer, avoiding the extra labor imposed by the use of sugar cars or wagons. With these improvements, a "plant" of the size referred to (and even if larger, but single, the increase is limited to those employed upon the centrifugals, packing, and loading), the number of men would be about the following: Attending boilers, 1; furnaces, 2; mills, 2; juice strainer, 1; mill engines, 2; vacuum engines, 2; defecators, 3; skimmings, 1; apparatus, 1; pan, 7; centrifugals, 3; and for filling, weighing, sewing, and loading sacks, about 1 man for every 8,000 pounds of sugar. This would be approximately 30 hands in all at 65 cents per day, or less than 10 cents per sack of 325 pounds, with 12 cents more per sack as pay for the sugar maker. Filter press work is not included, because at the low price of sugar in Cuba it is still doubtful whether or not the expense of this improvement is compensated when the skimmings are properly redefecated. The other principal expenses of the manufacture would be per month: Engineer, $150; assistant $100; cane weigher, $68; book keeper, $70; overseer, $68; centrifugal man, $68; watchman, $50.

To this, of course, taxes, supplies, and interest of capital are to be added. As regards the latter, this estate has probably not cost over $160,000, or, if this amount has been exceeded, it has been through injudicious expenditure. The *direct* taxes are not heavy, and only the indirect bear heavily upon the industry in this island. We have yet to deduct from these expenses the value of the molasses, which, with facilities for shipment which this estate possesses, would at the present low prices be about 50 cents for each sack of sugar made.

There is still another very potent factor for evil or for good which must be taken into account in the economy of a factory of this class—the sale of goods to the laborers and tenants. Since the emancipation of the slaves, all sugar estates have a shop or "store" for this purpose. On those where the work is done by contract, as the contractors derive the greater part of their gains from the same source, the privilege of selling is often rented to a shopkeeper, but it is advisable in any case for the proprietor to retain this in order to keep the prices of the contractors within reasonable limits. Unfortunately for themselves, the planters sometimes monopolize this trade as a means of extortion, and it is the best device that has been yet discovered for driving the better class of hands away from the place, and always thus defeats its real aim. The profits in this country upon goods are so large that in a factory of the class referred to, by selling the supplies at reduced prices the best laborers may be drawn to the estate at lower wages, and margin enough still be left to pay a very considerable part of the expenses.

With these data I will leave the reader to make his own deductions in respect to the cost at which sugar is and might be produced in Cuba under the most favorable conditions, but there is still one other fact he should bear in mind. The factory taken as a type is comparatively a small one, and by doubling its output the proportional expenses would be still further reduced, perhaps 30 per cent.

The case to which the principal statements are applicable is, of course, an exceptional one, but it is nevertheless very far from being unique, for there are a considerable number of estates similarly situated on which it is to be supposed these natural conditions have been utilized to a greater or less extent. One at least I can cite to prove that I have not taken the highest type of a factory, making this year over ten thousand tons of sugar, which pays for its cane only $1.16 for the short ton placed upon the cane carrier.

The cheapness with which cane can be produced from the richest virgin soils of this island is truly surprising. If the fields are burnt over after the second or third crop, to rid them of their stumps in order to use the plow, the cultivation is identical with that of corn, or more properly maize, excepting in the moving of the trash from one row to another; but even this work is compensated by the relief from that of planting the seed each season, for on these fertile lands planting is only requisite once every eight or ten years. Nothing can vie with them unless it be the famous "crablands," where, according to report, the proprietor has only to cut the crop yearly and myriads of crabs do all the rest, stirring and manuring the soil by their burrows, and cutting the weeds to the ground for food as fast as they appear.—*Santiago Dod in La. Planter.*

THE CULTIVATION OF THE CHESTNUT.

MR. SAMUEL C. MOON read before the American Association of Nurserymen, fifteenth annual meeting, in this city, the following paper on this subject:

Chestnut culture in orchards is a young industry in this country, and although it has already been proved to be profitable, the subject is as yet imperfectly understood. The chestnut tree is widely distributed throughout the country, and yet there are large districts in which it is not found, and the question is often asked whether it will grow on bottom lands or on limestone lands? I cannot reply to these questions, and would be glad if some experiment station would investigate this subject. In Arthur Bryant's book on forest trees it is said that "the chestnut seems to prefer the sides and neighborhood of hills and mountains with a dry, sandy or gravelly soil, although it will grow on almost any soil except a wet one. It does not appear, however, to grow more rapidly in the rich soils than on the poorer lands. Lands utterly worthless for cultivation may be made to yield an income by planting them with chestnuts."

No trees which are equally well adapted for avenues will yield any return like our native nut-bearing trees, and none are more appropriate for shade and ornament about buildings or along farm lanes or in pasture fields.

In planting the chestnut, whether in orchards or avenues, the trees should be set at least forty feet apart, and some varieties will need forty-five or fifty feet. Like other fruit trees, they should be mulched, or the land should be kept mellow about them while they are small, and they will come into bearing as soon as apple trees or pear trees. Wild trees usually commence bearing when from twelve to twenty years old, and grafted ones of the most productive varieties from two to seven years after grafting. A chestnut orchard of the Numbo or Paragon varieties will come into bearing condition as soon as an orchard of Baldwin apples. Both of these varieties possess the qualities which make any orchard fruit profitable—that is, hardiness of the tree and early fruitfulness, with large size and fine appearance of fruit.

Efforts to introduce the Maron de Lyon and other large European varieties have not been successful, for although the trees may live a few years, they ultimately die. Trees imported from Europe and trees grown here from imported seed are not generally hardy; but stock raised from the seed of the exceptionally hardy European trees that do flourish here have proved hardy themselves, and in this way a strain of European chestnuts has been secured which will endure the climate of the Eastern States. Many individual native trees in different parts of the country have local reputation for superiority, and are no doubt worthy of dissemination, but they have never been introduced, and, like other new fruits, will need to be tested in different sections and under varied conditions before they can be confidently recommended. As the demand for new and improved varieties develops, there is little doubt but that superior kinds will be found and disseminated.

In habit of growth the American chestnut differs from the European about as the sugar maple differs from the Norway maple. The foreign chestnut branches low and forms a round-headed tree, while the native variety grows taller and more spreading. The Japan chestnut seems to be smaller than either of the others, with smaller foliage, and its slender, compact habit makes it an acquisition for small plantations. None of the large chestnuts, and no foreign chestnut that I have seen, equals in flavor the small ones on our native trees when they are eaten uncooked. They lack the sweet and delicate taste with which we are familiar, and there is an astringency in the skin which covers the kernel, but boiling or roasting corrects this unpleasantness, and after being cooked there is little difference in the taste of the foreign varieties and our own.

When the culinary uses of chestnuts are appreciated here as they are in Europe, where the cooks prepare them in a variety of ways, the demand for those of large size will rapidly increase.

I find the chestnut an expensive tree to raise, and this cost of production is an obstacle in the way of its general cultivation. I have found difficulty in grafting the trees and loss in transplanting them. It has not paid to graft them until after they are once or twice transplanted and when the stocks are three or, better yet, five years old. My most successful take of grafts yielded seventy-five per cent. of salable trees, but I have more frequently had seventy-five per cent. of failure. I have tried taking up one year's seedlings and grafting at the collar as apples are worked, on whole roots. I have tried collar grafting of one year old seedlings as they stood in the nursery row, using ordinary tongue grafts, but with no success. I have failed also entirely with ordinary budding. I have been most successful when I cut the cions early in spring and kept them dormant in an ice house until the stocks started and the buds on them were well swollen.

My practice then is to cut off the tops and insert tongue grafts wrapped in waxed muslin in the ordinary way. In some cases the grafts do not unite well, and there is no perfect union between stock and cion,

Such trees, of course, are short lived and worthless. This defect is more common with some varieties than others.

I have one valuable variety that I have never yet succeeded in grafting. Three years ago I headed in a large European chestnut tree with fifty grafts of the Japanese variety, and every one took and looked well. This year, however, I found the unions all imperfect, and they will evidently soon decline.

The difficulty of successful transplanting seems to lie in the extreme sensitiveness of the roots to exposure and their slowness in re-establishing themselves in the soil. If the roots get at all dry, the vitality of the tree is wasted by evaporation before they become sufficiently established to supply the demand upon them. I therefore dig and handle chestnut trees on damp and drizzling days and puddle the roots as soon as they are dug. These difficulties are annoying, but I do not consider the obstacles insurmountable. What is needed is extra care in every part of the work of handling the trees, from the time the seeds are sown until the grafted trees are set in their permanent positions, and I believe that after intelligent effort and experiments have been made by a large number of practical nurserymen in this direction, means will be found by which the trees can be produced as rapidly and cheaply as they are needed.

In the discussion which followed it was explained by Mr. Fernow that the chestnut is not so particular about the chemical composition of the soil as about its mechanical condition. Where the chestnut does not thrive on limestone land it is because the solid rock not far below the surface obstructs drainage. In limestone lands where there is an open, permeable subsoil the chestnut flourishes. The same causes sometimes exclude the tree from alluvial bottom lands. To attain the best growth it needs deep, free, and open drainage.—*Garden and Forest.*

THE QUANTITATIVE ESTIMATION OF COLORING MATTERS BY MEANS OF THEIR ABSORPTION SPECTRA.

By T. L. PATTERSON, F.I.C., F.C.S.

PERHAPS there is no property so characteristic of an elementary body as that observed when the light which it emits in a state of incandescence is examined under proper conditions by means of the prism. The smallness of the portions of matter required to be operated on, the delicacy of the reactions, and the definiteness of the results, all tend to make prismatic analysis a most exact branch of physical science and a very attractive study.

The same cannot be said of absorption spectroscopy. Here we have no lines whose position can be measured with exactitude, except in one or two instances. Neither can we operate on such minute quantities of matter. Nor is the range of bodies great which can be examined in this way. Only colored bodies, as a rule, are available; and of these only those which absorb light selectively. There are, however, a goodly number still left which we may turn to practical account; and it is to some of these and the method of their determination that I ask your attention to-night.

Several attempts have been made to estimate coloring matters by means of their absorption spectra. So far as I have been able to ascertain, Vierordt* in 1871 was the first to arrange apparatus for this purpose. His method consisted in the use of two slits—evidently in line—in front of an ordinary spectroscope, one for a standard solution of the coloring matter under observation, the other for one of unknown strength. By adjusting and measuring the width of each slit by means of a micrometer screw where absorption in the two solutions was equal, he was able to calculate the strength of the unknown one.

Hugo Schiff, in the same year,† proposed to estimate the coloring matter in aniline salts and blood, etc., by diluting a strong solution of known strength until a certain thickness had the same intensity of absorption when examined by an ordinary spectroscope as a similar thickness of the solution of unknown strength. By observing the amount of dilution, the coloring matter was readily ascertained.

In 1874 Hennig‡ used the absorption spectra obtained when light of equal intensity was passed through two columns of colored liquid. One of these was a weak solution of known strength, gradually augmented until the absorption bands were equally intense. From the concentration of the known column and the height of both, he calculated the amount of coloring matter in the unknown one.

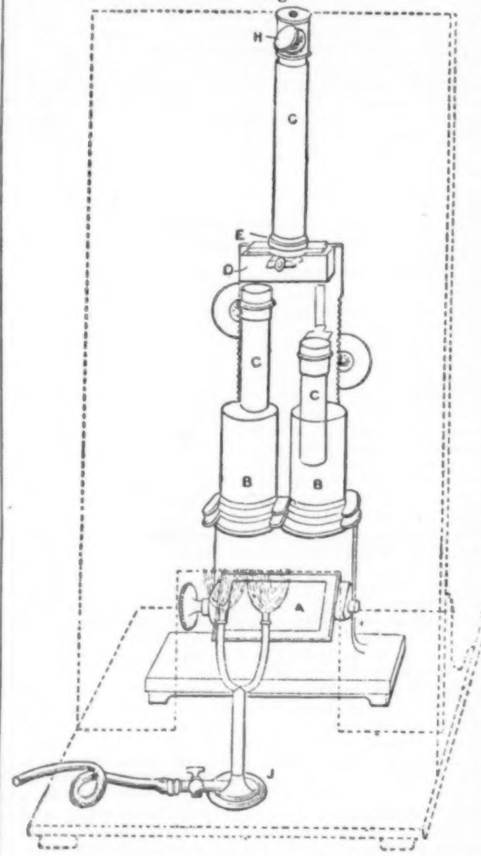
H. Kruss§ in 1882 proposed the use of a slit with adjustable sides, by which he estimated the coefficient of absorption for solutions giving band spectra, but I am not familiar with the details of this process. And

G. Kruss‖ in 1887 described a universal spectroscope for qualitative and quantitative analysis of a complicated construction, with two slits in front like Vierordt's and a slit in the eyepiece for cutting off all but those parts of the spectra under examination. The slits were all controlled by graduated micrometer screws, and the intensity of the absorption bands measured thereby.

As far back as 1873 I devised a method for estimating the amount of coloring matter in solutions which gave band spectra, by adapting a glass tube to the low power objective of a microscope which worked vertically in a larger tube fitted to the sub-stage. On examining the light, transmitted through a colored solution placed in the lower tube, by means of a spectrum eyepiece having a comparison prism, over which was adjusted a sealed tube containing the standard solution, I was able to determine the height of a column of liquid of known strength, which gave the same band absorption as the tube over the comparison prism. The height of the column of liquid was adjusted by means of the sub-stage pinion, the head of which was graduated for the purpose. On now placing another solution of unknown percentage, but known strength, in the sub-stage tube, and adjusting the height of the columns to give the same absorption as before, the two spectra being viewed alongside each other in the eyepiece, it was easy to calculate the value of the unknown one. The quantity of coloring matter being the same in each column, the relative proportions were inversely as their heights, as in an ordinary colorimetrical estimation.

I used this apparatus occasionally and got fairly good results, but the method is tedious and requires very careful adjustment of the light and all the parts of the instrument. The body of the microscope must not be moved during an observation, or if so, it must be brought back to the same position it occupied before disturbance, otherwise the intensity of the light—varying as it does inversely as the square of the distance—would make some difference in the results. By moving the sub-stage in the path of the ray this error is avoided. Observations are made by setting the sub-stage milled head to the zero mark and lowering the body till the tube on the object glass touches the bottom of the sub-stage tube. On turning down the sub-stage the liquid flows in by displacement, and can be regulated to the proper height by noticing the coincidence of the bands in the eyepiece. Besides the care required in making an observation, another difficulty presents itself; for the separate comparison of two columns of liquid against a standard necessitates two readings, and consequently doubles the errors.

Fig. 1.



A. Mirror. B. Solution observation tubes. C. Displacement glass column lined with black paper or black velvet. D. Reflecting prisms. E. Adjustable slit. G. Spectrum eyepiece. H. Micrometer scale. I. Wood screen with dead black surface. J. Double gas jet. The centers of burners correspond with the optical centers of the instrument. The burners are set so as to present the edges of the flame to the instrument, not the flat side, as shown in the figure. K. Direct vision prisms.

Fig. 2.

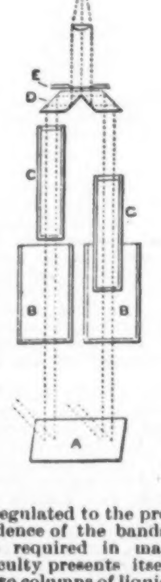
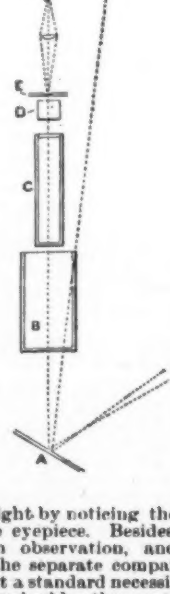


Fig. 3.



To avoid these I sought for a better method, and hit upon the idea of adapting a slit and spectrum eyepiece to a suitable colorimeter. The only one I know of which lends itself to this kind of work is that made by Laurent, of Paris. In this instrument two tubes with flat bottoms for holding the solutions to be examined are supported side by side on suitable clips or brackets. Two narrow cylindrical tubes with flat ends are arranged to move vertically in the larger tubes, by means of rack and pinion on the sides of the instrument, with a range of 50 mm. graduated to half a mm. Over each tube a glass prism is placed, which reflects the light transmitted from a plane mirror beneath into an eyepiece, in which the two rays are focused as semi-disks in one plane. Colorimetrical measurements are easily made with this instrument, and the readings are very close.

I found considerable difficulty getting a spectrum eyepiece fitted to the colorimeter. On taking it to a well known spectroscope maker in London he told me it was impossible, and would have nothing to do with it. Mr. Hilger fitted an eyepiece, but it did not suit. Ultimately I got Mr. White, of Glasgow, to fit an adjustable slit just over the reflecting prisms; and adapted the prismatic eyepiece of a micro-spectroscope myself, with the result that I now have an instrument which works perfectly. I mention these difficulties, not because they are of any consequence now, but to point out that one should not be discouraged because an optician cannot comprehend the principle involved in adapting a particular piece of apparatus to a special end. He must work it out for himself.

The slit opens out wide, and, as now designed, the instrument may be used with the eyepiece suited for each, either for colorimetrical or spectroscopic work—qualitative or quantitative.

In using the instrument, light reflected from the mirror beneath passes axially up through the solutions in the two tubes and movable columns, where it is received on the plane faces of two prisms cut so as to totally reflect the light twice at right angles. Both beams now pass the slit in a divided slice of light—so to speak—which is analyzed by a direct vision spectrum eyepiece, in which two spectra of equal intensity are seen. Gas or lamp light is better for this work than daylight, because it has no absorption lines to interfere with the bands; and the less refrangible end of the spectrum is brighter than with any but direct solar light. It is better to use a screen, as shown in the sketch, to shade extraneous light off the eyes.

A little micrometer is adapted to the eyepiece, by which the bands or lines can be measured or mapped. Of course, the Fraunhofer and bright line spectra can be examined as well with this instrument as with any other, but the dispersion being necessarily small, it is not possible to measure the lines with any degree of accuracy. This spectroscope is properly adjusted for work and ready for use when the slit has a proper width and the two spectra are seen in the eyepiece to have an equal intensity; and when the index of each cylindrical column points to zero on the scales, with the base of the columns just touching the bottoms of the glass tubes.

Fig. 1 is a general view of the spectrum absorptimeter. Figs. 2 and 3 are front and side views showing the path of light through the instrument. The corresponding parts of each figure are lettered alike.

If now a solution of any coloring matter which absorbs light selectively, say a dilute alkaline alcoholic solution of alizarine of known strength, be run gently into one tube from a pipette, the two characteristic bands which this body displays will be seen to come gradually into view, on turning up the milled head of the glass cylinder and allowing the liquid to flow in between the base and the bottom of the glass tube. By raising or lowering the cylinder, it is easy to get the exact thickness of liquid at which the bands are seen to the best advantage.

If another solution of alizarine of unknown strength—it may be more or less concentrated—be run into the other tube, and the milled head turned so as to raise the glass column, a point is easily reached at which the two spectra viewed in the eyepiece are seen to be equal. On reading off the heights of the two columns, the strength of the unknown one is found to be inversely proportional to the height of the columns and the strength of the known solution. Let the height of the standard column be a, and its strength b, the height of the unknown column c, and its strength x. Then x is found by the formula $\frac{a\,b}{c} = x$.

I have said it is easy to get the exact thickness of liquid at which the bands are seen to the best advantage. This requires some explanation. It is not advisable when making comparisons to work with the bands black or even very dark. They should possess a somewhat smoky color, if I may so speak, which is a dark shadow rather than a black bar; and not absorb all the light from that part of the spectrum in which they appear. The most characteristic band should always be used when there are more than one; and it is advisable in most cases to use a wide slit above the prisms to shut out all portions of the spectra except that under observation. Only in this way is it possible for the eye to judge of the shades of intensity obtained by movements of the milled head, and find the point of adjustment where no difference can be observed between the bands in the two spectra.

With these precautions a number of readings are fairly close and may be compared with those obtained with a colorimeter. But the accuracy depends to a large extent on the sharpness of the vision in the observer and a little acquaintance with the instrument. With small percentages great accuracy may be obtained, while with large percentages the readings will be less truthful, but the process is not intended for such, unless in exceptional circumstances.

I have made a number of experiments to test the accuracy of reading, and illustrate the method of work.

Olive oil gives a well defined band in the red end of the spectrum No. 1, which is suitable for testing the closeness of independent readings. A series of readings were made with the same specimen of oil in both tubes of the instrument. When the left hand column was 8 mm. high, a suitable absorption band was obtained for making the observations. The right hand column was then altered and adjusted until absorption in the two spectra appeared to be equal. The following are

* Chem. Soc. Jour., Vol. XXIV., pp. 602 and 759.
† Chem. Soc. Jour., Vol. XXIV., p. 760.
‡ Chem. Soc. Jour., Vol. XXVII., p. 495.
§ Chem. Soc. Jour., Vol. XLII., p. 1229.
‖ Ber. Chem. Ges., Vol. XIX., p. 2739.

the readings of the right column, the left remaining stationary at 8 mm.

1st	8
2d	7·75
3d	8·50
4th	8·25
5th	7·50
6th	8·25
7th	7·75
8th	8·00
9th	7·50
10th	8·50

The mean of these is 8 mm. with an error of 0·5 mm. ±.

Solutions of magenta in alcohol give a broad band of absorption in the green part of the spectrum No. 12, not very suitable for this kind of work, because broad bands are not so easily compared as narrow ones; but I have chosen magenta to show the amount of error to be expected in some cases.

A stock solution of this coloring matter was prepared containing 0·012 grm. in 400 cc. of alcohol = 0·00003 grm. per cc. A column of about 1·25 mm. was all that was required of this solution to give a suitable band for examination, but this column is too short for close comparative work; therefore 5 cc. were diluted to 100 cc. with alcohol and used as a standard in the following experiments.

Four solutions, *a*, *b*, *c*, and *d*, were made containing respectively 20, 10, 4, and 3 cc. of stock solution in 100

Fig. 4

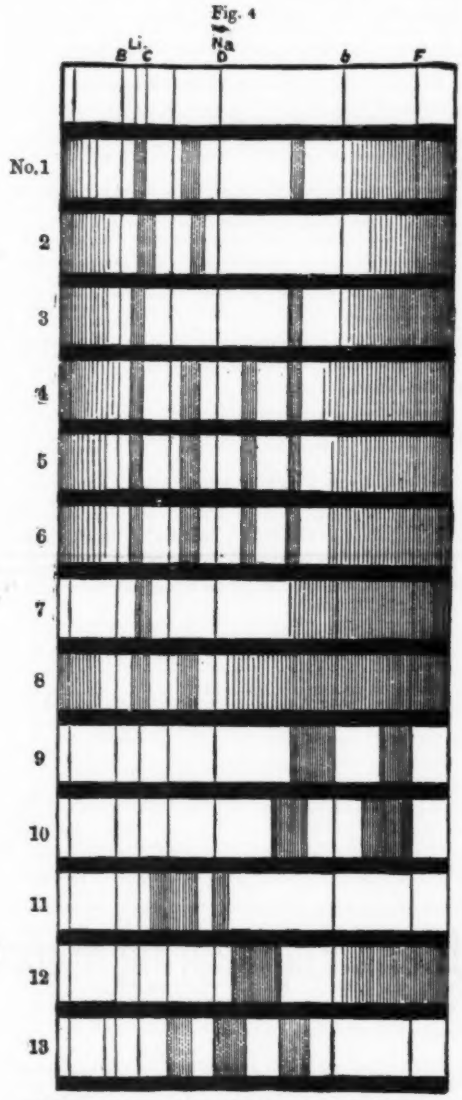


DIAGRAM OF ABSORPTION SPECTRA.

1. Olive oil, yellow. 2. Olive oil, green. 3. Linseed oil. 4. Rape oil, brown. 5. Rape oil, green. 6. Hemp seed, brown. 7. Hemp seed, refined. 8. Menhaden oil (mixed with brown rape). 9. Eosin, V. E. 10. Erythrosine, R. E. 11. Aniline green. 12. Magenta. 13. Alizarin.

cc. of alcohol. Each was examined separately against a column of the standard solution, and five readings were taken of each solution when the absorption in the two spectra appeared equal, after readjusting for each reading.

a. The readings for this solution were 8, 7·5, 7·5, 7·25, and 8, the mean of which is 7·65 mm. when the standard column stood at 30 mm. Calculated from the strength of the solution, the reading should have been 7·5 mm.

b. The readings were 14·75, 14·5, 15, 14·75, and 15·1, mean 14·8 mm., against a standard column of 30 mm., and the calculated height is 15 mm.

c. Read 38, 37·25, 37, 37·5, and 37·1, mean 37·37 mm., when the standard column stood at 30 mm., the calculated height being 37·5 mm. And

d. Read 42, 42, 41·5, 41, and 40, mean 41·5 mm., when the standard measured 25 mm. The true height should have been 41·66 mm.

Aniline green gives a well-defined band in the red No. 11, somewhat like chlorophyl, but more refrangible. A series of experiments were made with this coloring matter in the same manner as with magenta. The weight dissolved was the same, as also was the solvent and the dilutions; therefore I need not repeat them here.

a. When the standard column measured 33 mm., the readings with this solution were 7·6, 7·25, 7·5, 7·5, and 7·25, mean 7·42 mm. Corrected for strength, the height should be 7·5 mm.

b. With the standard column at 25 mm., read 12·1, 12·5, 12·5, 12·6, and 12·1, mean 12·36 mm., instead of the calculated height of 12·5 mm.

c. Against the standard at 25 mm. read 32, 31·5, 30, 29·75, and 32, mean 31·05 mm. instead of 31·25 mm. And

d. With standard at 20 mm. read 33·25, 33·5, 33, 33, and 33, mean 33·15 instead of 33·33 mm.

Tabulating these results and calculating them to 100, we find the error in reading to be as follows:

TABLE No. 1.—MAGENTA SOLUTION.

—	Calculated Height of Column.	Mean Height of Five Readings.	Colouring Matter found.	Error due to Reading.
	Mm.	Mm.	Per Cent.	
a	7·50	7·65	98·04	− 1·96
b	15·00	14·80	101·36	+ 1·36
c	37·50	37·37	100·35	+ ·35
d	41·66	41·50	100·39	+ ·39

TABLE No. 2.—ANILINE GREEN.

a	7·50	7·42	101·08	+ 1·08
b	12·50	12·36	101·13	+ 1·13
c	31·25	31·05	100·64	+ ·64
d	33·33	33·15	100·54	+ ·54

The eye-piece slit was used with the green solutions, but not with magenta, as, in the latter case, better results were got without it. The errors recorded are less with dilute than with strong solutions, but none are excessive when we consider that this is the most trying method of testing a process which is only intended for estimating small percentages of coloring matter. It would be easy to multiply such experiments, but those I have given will suffice to show the error of reading and the minute quantity of coloring matter required to make a quantitative estimation. The *d* solutions contain only 0·00009 = $\frac{9}{100000}$ of a grm. per 100 cc., and much less would be required if the solutions were concentrated.

In the experiments just detailed, I have dealt with simple coloring matters; but when the absorption bands occur in different parts of the spectrum, there is no reason why two, or even more, should not be determined in the same solution. By way of illustration I will mention the results of some experiments with mixtures of solutions of the two coloring matters—magenta and aniline green—we have been considering. Known quantities of these were mixed in varying proportions, thus—

I.—Contained 3 cc. stock solution of magenta and 20 cc. stock solution of aniline green in 100 cc. alcohol.
II.— 5 cc. magenta to 20 cc. green.
III.—10 cc. " 20 cc. "
IV.—20 cc. " 20 cc. "
V.—10 cc. " 10 cc. "
VI.—20 cc. " 10 cc. "
VII.—20 cc. " 5 cc. "
VIII.—20 cc. " 3 cc. "

all made up to 100 cc. with alcohol.

I need not record the various spectroscopic readings. It will be sufficient to say that the mean of five was taken in each estimation against the same simple standards as were used in the previous experiments. The errors were small with aniline green, but larger with magenta, especially in the strongest solutions. Calculating the cc. of coloring matter in 100 cc. of alcohol in each experiment, to 100 of mixed coloring matter, and recording the result of the readings in percentages, the errors are brought into relief. This has been done in the following table.

Table No. 3, showing the percentage of magenta and aniline green found in mixtures of these coloring matters:

the band under examination; but it did not affect these estimations. Green, for instance, darkens the total spectrum a little, but where it was present in largest quantity, as in experiments I. and II., the error in the magenta estimation was least, and *vice versa*.

Turning now in another direction, let me cite a few examples illustrating the application of this method of analysis to ordinary quantitative work.

The estimation of alizarin in alizarin paste is an operation which involves a considerable amount of time and manipulative skill in precipitation, filtration, and washing. Considerable difficulty, too, is experienced in getting rid of associated coloring matters. With the spectroscope the quantitative estimation is as easily performed as is that of aniline green or magenta, and the foreign coloring matters interfere very little with the observations. Three samples of alizarin paste were examined in this way: 0·025 grm. of each was dissolved in alcohol and rendered alkaline with a sufficiency of alcoholic potash to give the characteristic absorption No. 13, and made up with alcohol to 100 cc. For comparison, a specimen of pure alizarin was prepared by sublimation from alizarin paste, after solution in caustic soda, precipitation with $BaCl_2$, and washing, followed by decomposition with HCl and washing, etc. A standard solution of the pure sublimate was then made containing 0·004 per cent. of alizarin. On comparing these solutions in the spectrum absorptimeter—to give the instrument a name—and calculating the results from the mean of five readings which closely agreed, the first was found to contain 5·33 per cent. alizarin, the second 7·69 per cent. alizarin, and the third 23·36 per cent. alizarin. Of course all here depends on the purity of the standard specimen, and every effort should be made to secure it. I do not say mine is absolutely free from impurity, having only been made for the purpose of this illustration; but so far as it is pure the results are very close to the truth. The first sample is said to be 7 per cent. and the second 10 per cent. Both are very old specimens. The third was in the condition of putty, and has, I may mention, a somewhat curious history. It came from Germany in a lot of beetroot sugar, and passed the samplers unnoticed until the sugar was being melted in the refinery. The alkalinity of the sugar developing the purple color of the alizarin and dyeing the men's hands was the occasion of drawing attention to it. On examination it was found that the sugar had been filled into bags which had been previously used for packing alizarin paste. The insides of the bags were smeared with alizarin, and some of them contained masses of 20 or 30 lb. of that coloring matter. Altogether between 3 and 4 cwt. were recovered from that lot of sugar. I should add that I am inclined to believe the presence of alizarin in this connection accidental, although the cause of it was never satisfactorily ascertained.

A piece of Turkey red cloth weighing 0·963 grm. and measuring twenty-four square inches was treated with concentrated sulphuric acid, and the coloring matter precipitated with water, filtered, and washed. The alizarin on the filter was dissolved in alcohol and alcoholic potash and made up to 200 cc. On comparing this solution with the standard mentioned in the previous experiments, and figuring out the result, it was found that the cloth contained 0·83 per cent. alizarin and 0·4306 grm. per yard.

The coloring matters in sweetmeats, which are now so attractive and various, can be determined in this way—that is to say, those of them that have absorption spectra. The spectra of known coloring matters, of the same or similar tint, are compared with that of the sweet under examination until one is found to correspond. The amount is then easily ascertained. One example will suffice here.

Twenty grms. of a pink tablet were dissolved in alcohol. The solution gave two bands in the blue which exactly coincided with those exhibited by an alcoholic solution of V E eosin No. 9. When compared with a solution containing 0·001 per cent. of this coloring matter, the tablet was found to contain 0·00294 per cent. This is a very small and no doubt harmless quantity, yet it was easily recognized and estimated. The eosin family seem to be largely used for this purpose.

Many of the colored gelatin films used in confectionery give absorption spectra by which the coloring matters can be identified. I have found aniline greens and blues, magenta and eosin pinks, some of which fluoresce in the film almost as much as they do in solution. One grm. of a flesh colored specimen was dissolved in 400 cc. equal parts water and alcohol. The

TABLE No. 3.

Number of Experiment.	Magenta.			Aniline Green.		
	Calculated.	Found.	Error.	Calculated.	Found.	Error.
	Per Cent.	Per Cent.		Per Cent.	Per Cent.	
I.	13·04	13·51	+ 0·47	86·96	87·24	+ 0·28
II.	20·00	19·42	− 0·58	80·00	78·74	− 1·26
III.	33·33	32·42	− 0·91	66·66	64·10	− 2·56
IV.	50·00	48·87	− 1·13	50·00	49·75	− 0·25
V.	50·00	49·66	− 0·34	50·00	49·70	− 0·30
VI.	66·66	63·54	− 3·12	33·33	33·11	− 0·22
VII.	80·00	77·00	− 3·00	20·00	19·83	− 0·17
VIII.	86·96	83·70	− 3·26	13·04	12·94	− 0·10

Experiment V. was made with half the coloring matters present in No. IV. solution. The magenta estimation is very near the truth, but I consider it doubtful in the absence of other experiments. A careful examination of table 3 reveals a tendency to overestimate the height of the working column, giving a — error in every determination except the first. The high percentages are not closely estimated, especially in the case of magenta. But from 50 per cent. down the — error has a ratio decreasing with the percentage of coloring matter, confirming what I have already said, that better results are obtained with small percentages. The decreasing ratio and close reading are very marked in the estimation of aniline green. A slight general absorption of the whole spectrum takes place with two coloring matters in the same solution, which under certain circumstances abnormally darkens

spectrum agreed with that of V E eosin and revealed the presence of 0·162 per cent. of this coloring matter when compared with a standard solution containing 0·001 per cent. dissolved in water and alcohol. A purple film treated in the same way yielded 0·66 per cent. of magenta.

A paraffin candle was found to be colored with erythrosine R E; No. 10 spectrum. Five grms. were dissolved in gasoline, and shaken up with alcohol in a separator. The coloring matter was thus transferred to the alcohol. After removal the colored solution was made up to 100 cc. with the washings from the gasoline, and compared with a standard containing 0·001 per cent. of erythrosine. Twenty mm. of the standard equaled 9·38 mm. of the candle solution, indicating 0·043 per cent. of erythrosine.

Sometimes a colored impurity may be turned to ac-

count for the quantitative estimation of the substance in which it naturally exists; and though not always present in exactly the same proportion, it can give some definite information which may lead to useful results. The analysis of oils is a case in point. I have often found the spectrum absorptimeter useful in approximately determining the amount of adulteration where certain vegetable oils were mixed with those of animal origin. Chlorophyl is of course the coloring matter which enables us to recognize the mixture. It is always present in certain unrefined vegetable oils as an impurity, and its quantity is fairly constant in fresh specimens of the oil. One glance at an oil with a pocket spectroscope is sufficient to reveal the absorption bands when they exist; and the quantity of the oil giving them can afterward be determined in the absorptimeter. The spectra of oils giving chlorophyl bands have often been referred to and mapped, but I am not aware that any attempt has hitherto been made to utilize the bands for quantitative work. Unfortunately, chlorophyl is not always stable. The bands are often eliminated by refining and long exposure to light, especially those in the more refrangible end of the spectrum.

Hence fresh samples should always be used for comparison, and when kept for any time, should be preserved in the dark. The band in the red is well defined* and very characteristic. The other three are all more or less faint and only seen in good fresh specimens. The intensity of chlorophyl absorption in hemp seed, brown rape seed, green rape seed, linseed and olive oil is in the order just named; and the bands have the same width and position for an equal intensity. Their spectra are shown in the diagrams, Nos. 1 and 3-6. Green olive oil differs from the others in this, that it has only two absorption bands, one of them very faint, and these are more refrangible, as seen at No. 2. In linseed and olive oil the secondary bands are very faint and seldom met with. It is therefore comparatively easy to distinguish green and yellow olive and linseed oil from others of the band-giving class. When the oil in a mixture is not one of these, or when there is any doubt, it may be recognized by chemical tests and its quantity found by the absorptimeter. It is a good plan to map the absorption spectra of oils which give them on sectional paper for reference, so that when a mixed sample turns up, it can be seen by means of the eye-piece scale which of the oils already mapped the mixed specimen must be compared with. The comparative estimation should not be made unless the bands in the two spectra occupy the same position, and can be brought to the same intensity.

The most common adulteration of this kind which I have noticed is that of mixing linseed with fish oils. But olive and rape are also mixed with these and other oils. Whale, seal, and porpoise oils are all mixed with linseed in varying proportions, and no one whom I have asked seems to know the reason why; indeed, the oil merchants pretend to be totally ignorant of the mixture. Unless whales and other fish have become vegetarians and store up chlorophyl in their fat cells, there must be some manufacturing reason for chlorophyl bands appearing so often in oils of this class. Perhaps the price of vegetable oils, which is usually above that of fish oils, puts them out of the category of adulterants into that of improvers; for their addition undoubtedly brings up the color of dark fish oils, gives them more body, and reduces their smell. But this only removes them from one category to another, and is no justification for the mixture. Whether the soap boiler, the jute manufacturer, and the leather dresser, who use fish oils in large quantity, are prepared to homologate this practice, I cannot pretend to say, but it is worthy of their consideration because of the extent to which it is carried.

Take the following examples:

1. A sample of whale oil gave a strong band of absorption in the red corresponding with the band in linseed oil. On comparing these two oils in the instrument, the height of the whale column was 11·09 mm. (mean of five closely agreeing readings) against 5 mm. of linseed, indicating $\frac{5 \times 100}{11 \cdot 09} = 45 \cdot 08$ per cent. of linseed oil.

2. Another sample of whale oil absorbed light like green olive, and 15·63 mm. were equal in intensity to 3 mm. of that oil. It therefore contained $\frac{3 \times 100}{15 \cdot 63} = 19 \cdot 19$ per cent. of green olive oil.

3. A sample of seal oil was found to give the linseed spectrum, and 24·13 mm. were found to equal 8 mm. linseed, which shows this oil to have contained $\frac{8 \times 100}{24 \cdot 13} =$ 33·11 per cent. of linseed oil.

4. *Menhaden Oil*, the product of a small fish very plentiful off the coast of North America, is, I fear, not to be had pure. I have examined three samples and found all mixed with vegetable oil. Two of these were said to be pure, and contained respectively about 14 per cent. and 25 per cent. of linseed oil, while in the third, 18·44 per cent. of brown rape oil was present. The presence of rape was confirmed by Valenta's test,† and the saponification equivalent. The spectrum of this oil, No. 8, is much more intense than that of the darkest pure linseed oil I have seen, and some of the secondary bands are visible. Yet its outward appearance is not different from that of a pure brown fish oil.

5. A sample of lard oil, purchased as pure and genuine, will be the last example. It was found spectroscopically to exhibit the band characteristic of green olive; and when compared with pure fresh samples at the time of purchase, now upward of two years ago, indicated the presence of 11·7 per cent. of green olive oil.

As I happen to have this sample of lard oil beside me still, as well as the green olive against which it was tested, I thought it would be instructive to compare them again. The lard oil stood on a shelf in the laboratory, exposed to light all the time, but the olive was carefully protected from light, for testing purposes, by gumming black paper around the bottle. The lard oil was also tested against a fresh sample of green olive of recent date. On making the experiment, the lard oil indicated 8·8 per cent. against the old sample of green olive, and 7·02 per cent. against the new one. The result is very interesting, as it indicates a loss of chlorophyl by the bleaching action of light equal to about 4·68 per cent. of the olive oil originally found in the lard, while the olive oil protected from light may be said to have lost little or nothing of its chlorophyl during two years. 1·78 per cent., the difference between the last two estimations, may be due as much to difference of sample as to loss of chlorophyl. The experiment illustrates what I have said above on the persistency of the *a* band and the action of light on chlorophyl.

In drawing this paper to a close, let me say that I have only referred to a few applications of this instrument and method of analysis; they are chiefly those to which I have had occasion to apply them myself, and others will suggest themselves to every chemist. The coloring matter in cheese and butter can be determined; so also might fuchsine and elderberry juice when present in wines. Some of the impurities in anthracene absorb light selectively, which property might be utilized for their estimation. There are many processes in the arts where fairly accurate results have to be got in the least possible time, where this spectrum method might be found useful; as, for instance, in many dyeing operations. While there are others in ordinary laboratory practice, where the quantity of coloring matter is so minute and difficult to separate and weigh that this method of determination will be preferred to a gravimetric one.

In conclusion, I beg to acknowledge the valuable assistance of my friend Mr. John McGlashan, who has made all the experiments in connection with this paper. I have also to thank Mr. Hugh Lusk for preparing the diagrams, and several friends who kindly procured for me pure samples of oils.—*Jour. Soc. Chem. Industry.*

* I have some samples which have not lost the *a* band, although exposed to light for several years. In dark oils the band is very persistent and alters very little during many years.

† See Allan's Com. Org. An., Vol. II., pp. 25 and 40.

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